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NOTES AND COMMENTS.

Research in Foundry Work.

Much advice as to the types of research which should be taken up by the British Cast Iron Research Association has been given at the various branch meetings of the Institute of British Foundrymen, but an excellent example of work which would be appreciated by all foundrymen is given in a brochure published by the Falkirk Foundry Institute, of which we give an extract on another page. It has been stated that the Association will avail itself of all current technical literature, and it would do well to follow a similar policy with regard to its research work, if suitable arrangements could be made with established laboratories and workshops. Whilst a central establishment should be formed, we see no reason why the testing laboratories established at the National Physical Laboratory, Birmingham, and Sheffield Universities and elsewhere should not be used. It is not usual for the more expensive pieces of apparatus installed in the technical departments of the modern universities to be working at anything like full pressure, and such work as the breaking of test-pieces for the Association in such establishments would fulfil the dual rôle of supplying results without a capital outlay and familiarising students with the use of the machine and the calculation of results obtained therefrom. The experimental plants, such as open-hearth, crucible, and electric furnaces, which have been installed in these institutions cannot be used as often as the professors would like, owing to lack of funds. Here again existing plant could be used for the mutual benefit of the trade and student. By utilising existing plant, should it be possible to make suitable arrangements, much money could be conserved for the primary object of the Association, that is, the prosecution of the research work so urgently needed by the industry. An objection to such a system might be raised on the grounds that the results are intended for British foundries only, and by using the plant installed in educational institutions, foreign students would be able to utilise the information when they returned home, but we are convinced that major portion of research work is routine, and could be so distributed as to even mask its purpose, except in very rare circumstances. Another advantage, which is not quite so obvious, is that the Director of the Association would have the co-operation of the staffs of the Institutions used, and this should help in the formation of considered opinion. Summarised, the benefits obtained from such a system would be the saving of capital expenditure, the educational instruction of the student, and the co-operation of the majority of the scientific workers in technical colleges. Against these must be placed the increased organising work of the Director, loss of time, leakage of confidential information, and the liability of samples being mixed, resulting in erroneous deductions.

Why the Iron Foundry has been Neglected.

This subject has recently been discussed owing to the formation of the British Cast Iron Research Association. The question seems curious, as its sister industry, the manufacture of steel ingots, is one of our most up-to-date industries. A reasonable explanation seems to lie in the fact that for most purposes where exacting conditions are to be considered cast-iron has been ruled out in favour of steel. The cast-iron industry has never been localised in the same manner as the steel industry, and there has been less chance for the exchange of ideas and personnel. Another, and perhaps more profound, reason is the increased complexity of cast iron in comparison with steel. Other considerations worthy of investigation, as to the cause, is that foundries were often worked to supply local needs, whereas the operations of the steel trade were world-wide and had to meet international competition. As a war material cast-iron is second to steel, and national security and ambition has led Governments to take an interest in steel works so as to obtain materials superior to those emanating from foreign countries. In their search for materials for armaments, steels suitable for other industries have been discovered. Technical work for the iron-foundry has been, in the past, very largely derived from the application of theories evolved in the steel works, but it is not beyond the sphere of practical politics that, in the future, iron-foundry research work may contribute material knowledge to general metallurgy, of which the steel trade will be only too glad to avail themselves, and in a measure reverse past history.

THE late Mr. J. H. Hutchison, shipbuilder, of Newcastle-on-Tyne, left £8,723.

A Design of an Iron Foundry.

B. L. Tibbenham (Winner of the First Prize in the Foundrymen's Competition).

The foundry described herewith is specially laid out for jobbing work, and has a capacity of 30 to 40 tons per week, for castings ranging from a few pounds up to two tons.

It is the object of the designer to construct a foundry on the simplest lines, and yet economical for working, no elaborate apparatus has been installed, but the plant is of the simplest kind, yet efficient, and castings should be produced at a competitive price.

The main building is of steel construction, with brick and glass sides, corrugated asbestos roofing.

The bottom tie in each side bay is arranged in the form of a runway. A further runway system is arranged from the cupola round the end of the building into the side bay, this enables the metal to be rapidly brought round to the moulding machines without stopping the cranes.

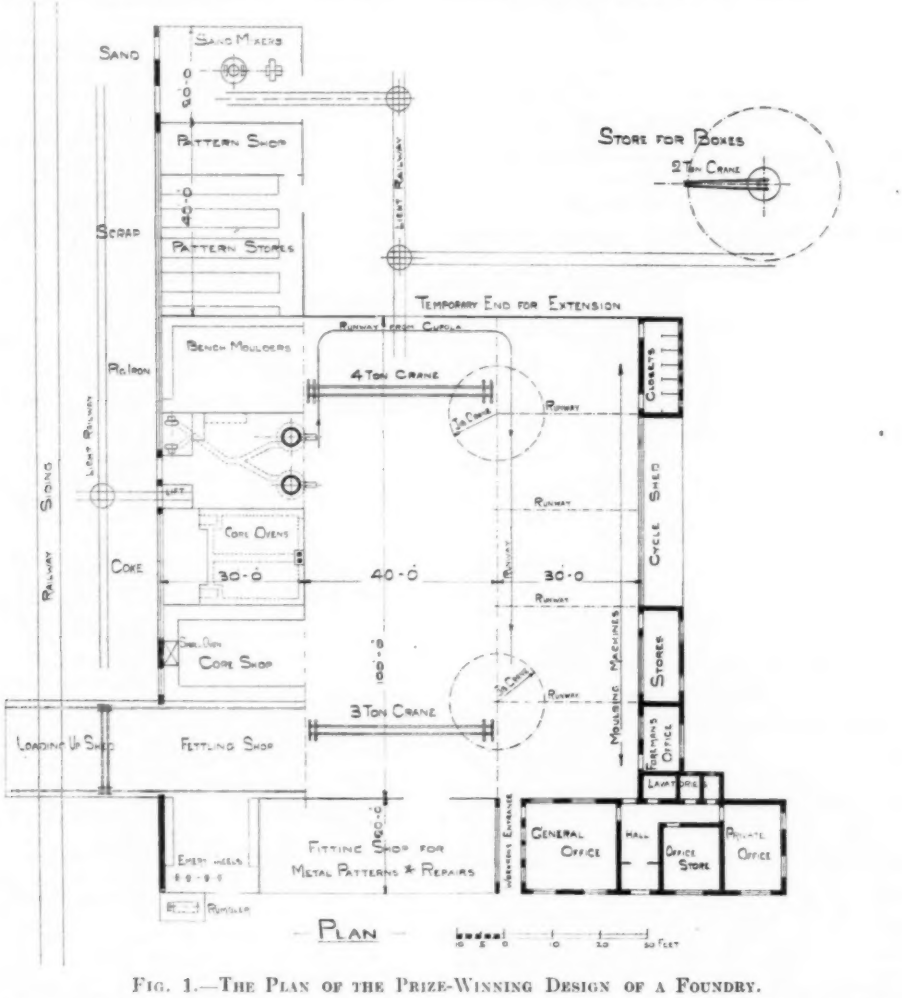

Fig. 1.—The Plan of the Prize-Winning Design of a Foundry.

It will be noticed that the building is particularly well lighted, and it should be quite possible in the depth of winter to work in this shop up to 5 o'clock without artificial light, which results in a great saving in these times of high cost of electric light.

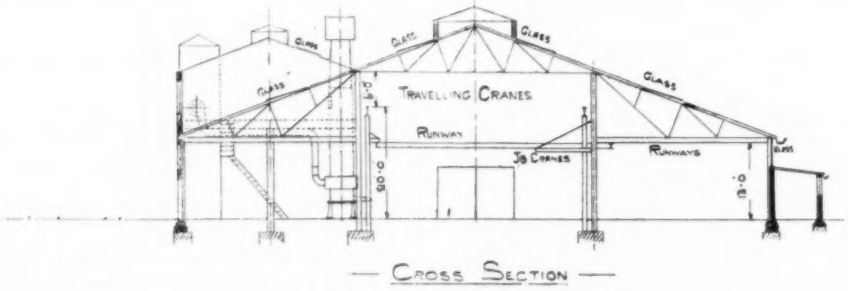

Fig. 2.—The Cross Sectional View.

The end of the building is so constructed that it can easily be removed for extension.

The building shown is adequately lighted and ventilated, and is divided into three bays. The middle bay is fitted with two travelling cranes, three and four tons respectively. Two of the columns are fitted with jib cranes.

The raw materials arrive by the railway siding, and are unloaded and stacked between the building and the railway, they are then transferred to their proper places by a light railway. A turntable is arranged in front of the lift which gives easy facility for loading the furnace.

The castings are cleaned by a rumbler, and a

small sand-blast, and are loaded up direct into the wagons by a convenient hand crane.

On starting up one cupola should be installed, but arrangements are shown for duplicate blowers and cupolas. The blower shown is direct-coupled to electric motor, and the cupola a "Greens" rapid type, with drop bottom, capable of melting five tons per hour. The charging platform is of amply capacity, and is served with a 1-ton electric hoist.

The coke-fired core ovens are provided with a slow combustion grate, very simple in construction, and economical to work.

A special department is fitted up as a metal patternshop. The building is of northlight principle, and the shop should be equipped with lathes, shaping machine, drilling machine, etc., and every opportunity given for making patterns for repetition work, and whenever possible the patterns should be mounted on plates or plaster. All moulding boxes should be drilled to jig, and faces machined, although at first it may appear that such a department is an extravagance, the amount of saving made by the proper adjustment of patterns and boxes more than balances the expense of the shop.

On referring to the plan, on the right hand side will be observed a space allocated for moulding machines. These are all hand operated, as it is found that good plates and good boxes are as efficient as expensive jar rammers.

A large pattern-stores, with a loft overhead, is within easy reach of the moulding floor, and a small pattern-shop is worked in conjunction with this, principally for patching up and correcting old patterns.

It will be noticed that the cupola is arranged towards the end of the building to enable it to have a central position when the extensions are made.

The principal aim of the equipment is to enable the workmen to have every facility for lifting, and is arranged in such a manner to enable the moulding operations to be carried out with the minimum of labour.

The general office overlooks the moulding shop on one side, and the fitting shop on the other. All the workmen pass through the passage adjoining the office. The foreman's office is in close communication with the manager.

The following special pieces of tackle are recommended: Large boxes should be turned over by the use of roll-over chains. This saves a great deal of time, avoiding as it does re-slinging, which is sometimes necessary when turning over boxes.

Core-oven bogey is pulled in and out of the oven by the overhead crane, small pulleys being arranged at the back and front of the oven.

Double hooks to be used on the cranes, which simplifies the shifting of a ladle to another crane.

Special tightening chains should be employed for withdrawing patterns, as by this means it is possible to obtain an even tension on all chains, which is absolutely essential for even drawing of patterns.

Turnover boards should be brought into use where ever possible, and a great saving results in keeping them in thorough repair.

The welfare of the men should also be looked after, and a bowling green or other form of recreation should be provided adjacent to the works.

MR. J. KEITH, managing director of James Keith and Blackman & Company, Limited, Arbroath, who died on February 23 last, has left a fortune of the value of £115,160, the net personalty being £107,629.

RANDOLF HENRY, 11th Earl of Galloway, of Cumloden, Newton-Stewart, Wigtownshire, a director of W. T. Henley's Telegraph Works Company, Limited, who died on February 7, has left personal estate of the value of £28,445.

SIR DUGALD CLERK is spending the summer months in America. He has promised to give an address on internal combustion engines for motor-cars at the meeting of the Society of Automotive Engineers to be held at the beginning of June.

SIR GEORGE B. HUNTER, chairman of Swan, Hunter, & Wigham Richardson, Limited, has been the recipient of a handsome presentation from the officials and men in commemoration of his forty years' association with shipbuilding on Tyneside. The presentation was made by Mr. W. Webster, the manager of the company's Southwick yard on the Wear.

The Failure of Metals.

INTER-CRYSTALLINE FRACTURE IN STEEL.

By D. HANSON, M.Sc. (National Physical Laboratory).

The cases of failure discussed by the author are those which occur only under certain circumstances, in material of normal quality, when the time during which the stress is applied is prolonged. In most of the cases evidence is available to show that, if rupture is produced rapidly, as for example in a tensile or impact test, the fracture is trans-crystalline.

Several cases have been observed in mild-steel boiler plates which failed in service. The first case is that of a steel wrapper plate from the combustion chamber of a marine boiler, which was severely cracked around the edges between the rivet holes. The chemical composition of the plate was not unusual, although the phosphorus content was somewhat high (0.07 per cent.). Tensile tests gave normal results for the centre portions of the plate, but the edges showed a low elastic limit and elongation, while notched-bar impact tests gave variable and low results. It was found, on microscopic examination, that the steel at the edges of the plate possessed a somewhat abnormal structure, in that the cementite occurred mainly in the form of inter-crystalline films.

The second case was from the drum of a water-tube boiler, and the cracks as before started mainly from the edges of the rivet holes, though some were found to start at the caulked edge of the plate. As in the previous instance the microstructure of the steel at the edges of the plate was found to be abnormal in that it contained inter-crystalline films of cementite.

The third case was found in a number of plates from a high-pressure marine boiler. In this case inter-crystalline cracks were found in the steel at a point where the thickness of metal was very great, including the wrapper plate of the boiler itself, two butt straps and a cover plate, a total thickness of 4 in. This case differs from the others in that no abnormality in the quality of the material could be found. A special test suggested and carried out by Mr. F. S. Tritton was made on the material of this plate with a view to ascertaining the method of fracture under a slow tensile test. The conditions were so arranged that a crack started at one side of the test-piece and developed slowly through it. The loading was stopped at such a point that the resulting crack, which had spread about ¼ in. through the metal in two hours, did not run entirely across the thickness of the test-piece. Subsequent examination showed very clearly that under such conditions there is no tendency whatever for the crack to follow the crystal boundaries. In connection with this latter case it was found that a number of the rivet heads had broken off in service, and examination showed that the cracking in this case was also inter-crystalline. The material appeared to be a mild steel practically free from carbon, and possessed a very fine crystal structure.

In connection with the first two cases of failure described above, it was thought that the presence of free cementite might indicate a condition of the steel particularly liable to failure by inter-crystalline cracking. The condition of the third boiler plate and rivets shows clearly that steel of normal quality may also fail in this manner.

The process of riveting itself is one which must necessarily lead to internal stresses, both in the riveted material and in the rivet itself, though under carefully controlled conditions these internal stresses may be small. If, however, in forming a steel plate into the form of a boiler, the edges do not fit together accurately and are forced into contact by riveting, serious internal stresses must be imposed on the material. In the action of riveting, if excessive pressures are used, the material of the plate under the rivet heads may be distorted to a sufficient extent to impose upon it serious internal stress. Furthermore, if the rivet holes do not register exactly and have to be forced into position and held there by the rivets, still further opportunity is given for the establishment of internal stresses.

Causes of Season Cracking.—At the present time it is recognised that season cracking takes place with great readiness in some materials under

the action of corrosive influences, and it has been supposed that such corrosive action is necessary for the development of inter-crystalline cracks. There can be no doubt that certain substances have the power of rapidly attacking the inter-crystalline material in a metal under stress, and in many instances the presence of a corroding agent is necessary for the *rapid* development of season cracking. In the cases which have been described in this Paper, the possibility of corrosion of the steel is present, and this factor must be considered in arriving at any explanation of the phenomenon. In all the cases examined definite corrosion of the cracks was visible in polished sections, but it is difficult to determine whether such corrosion preceded the formation of the crack or whether it occurred as the result of the penetration of corrosive fluids after the crack had been formed by the action of other causes. While it seems difficult to prove that corrosion has not played a part in cracking of this kind, there is evidence to show that corrosion may proceed without in any way following the crystal boundaries. Cases of failure in boiler plate steel of the same quality as that of the plates described have been found in which corrosion appears to have played a very important part. In these cases cracks were observed to start, always from the side of the plate in contact with the liquid in the boiler, and to spread gradually through the material in a direction practically at right-angles to the surface of the plate. These cracks ran both longitudinally and transversely across the plate, and were not confined to the region in the neighbourhood of the rivet holes. They were, as a rule, much wider than the inter-crystalline cracks which have been described, and were found to be filled with the products of corrosion.

Cracks of an exactly similar character have been observed in boiler tubes, starting from the water-side. In this case, however, there is no reason to believe that there existed any serious internal stresses in the material, or any serious stress due to the working conditions.

From the foregoing evidence it is clear that corrosion of boiler-plate steel may take place, both under conditions which exist in the working of the boilers, and under conditions of atmospheric corrosion without any preferential attack of the material in the crystal boundaries. In certain cases of season cracking which are ascribed mainly to corrosion, definite evidence has been produced to show that under certain circumstances preferential attack of the material in the crystal boundaries can take place; in the present examples, no such evidence has been found. On the other hand, it is believed that in some metals corrosion can play little or no part in the phenomenon of season cracking, and that the main factor is the existence of a severe internally or externally applied stress. Another possible factor which may greatly influence this phenomenon is the temperature of the material during the time which the stresses are applied. If failure is to be attributed to gradual movement of the boundary material, without corresponding plastic deformation of the material of the crystals, it is obvious that failure will occur most readily under temperature conditions which favour the flow of the boundary material, while leaving the material of the crystals themselves sufficiently strong to withstand the applied stress. In the case of steel, it has been found that the tensile strength and elastic limit do not appreciably fall off until the temperature exceeds about 300 deg. C.; these properties, especially the elastic limit, may be taken as measuring the stress which the material of the crystals will withstand without deformation, and they appear to be little affected by the properties of the material in the boundaries. On the other hand, there is every reason to suppose that flow of the boundary material will be facilitated by rise of temperature, and it would therefore be anticipated that the most favourable temperature conditions for season cracking, in the case of steel, exist within a temperature range a little below 300 deg. C. It is interesting to note that in all the cases described the working temperature was within this favourable range.

Spontaneous Cracking of Hardened Steel.—It is well known that hardened steel articles frequently develop cracks after the hardening operation has been carried out. Such cracks may not occur for some hours or even days after hardening, and it is further recognised that the formation of cracks is more likely to take place in articles of irregular cross section, and in articles which are not heated to a uniform temperature before hardening. These latter conditions necessarily imply the existence of severe internal stresses in the hardened article. Such spontaneous cracks are frequently "inter-crystalline" in character, in the sense that they follow the boundaries of the austenite crystals which existed at the moment of quenching. There is no reason to suppose that the amorphous boundary films are altered in character by the action of quenching: they do not appear to be weaker than the material of the crystals under the conditions of the ordinary mechanical tests—tensile, bend and notched bar tests—in which fracture normally takes place through the crystals.

In conclusion, it should be stated that there is no reason to suppose that iron and steel differ essentially from non-ferrous metals in regard to season cracking, and it appears probable that, under the influence of suitable accelerators, more rapid failure could be induced. Examples quoted in this Paper, however, appear to indicate that such failure can occur as a result solely of the stresses—internally or externally applied—to which the material is subjected.

THE PRESENCE OF INTERNAL FRACTURES IN STEEL RAILS AND THEIR RELATION TO THE BEHAVIOUR OF THE MATERIAL UNDER SERVICE STRESSES.

By Henry S. Rawdon (Physicist Metallography). Bureau of Standards, Washington, D.C.).

Summary.—Discontinuities or internal fractures exist in considerable numbers in some types of steel rails as well as in some other wrought-steel products. These may be readily revealed by deeply etching sections of the material. A method for revealing their presence without changing in any way the characteristic features of these internal defects depends upon magnetising the specimen and then bathing it in a suspension of fine iron dust in oil. The origin of these discontinuities is still somewhat in doubt. They evidently serve as the "nucleus" or starting point from which larger defects, termed "transverse fissures" grow, under the stress conditions to which the rails are subjected in practice. While the failure of rails by the formation of transverse fissures is one of the most serious and dangerous types occurring in American rails to-day, it is not to be necessarily concluded that all rails are prone to this defect.

Our report of the general discussion will appear in next week's issue.

THE INDUSTRIAL POSITION OF LIGHT CASTINGS.—A report on the light castings trade by a sectional committee of the Sub-Committee on Building Materials appointed by the Standing Committee on Prices and Trusts was recently issued (Cmd. 1,200). It states that the profits and trading margins are not unreasonable, but criticises the "monopolistic control" of the National Light Castings Association. Such combinations, the Committee think, should be brought under State surveillance on the lines of the recommendations of the Committee on Trusts. The industry specialises in the production of castings used in house building, such as grates, stoves, mantels, registers, rain-water pipes, baths, etc., and the Association is a trade combination which covers 95 per cent. of the British output, while the Builders' Merchants' Central Committee represents almost the whole distributing trade. The former fixes the prices below which iron castings manufactured by its members should not be sold in this country, and the latter issue to the great majority of builders' merchants instructions as to the minimum prices at which light castings should be sold "over the counter" from stock. By a pooling arrangement the Association penalises any member who increases his output, and rewards any member who reduces his output relative to the rest. The Committee consider this arrangement to be contrary to the public interest, and express the opinion that the giving of deferred rebates on condition of price maintenance and exclusive dealing should cease.

A Visit to a Continental Foundry.

By W. G. Thornton.

(Foundry Manager of Messrs. Cole, Marchent & Morley, Limited, Bradford, Yorkshire.)

Since the moulders' strike, the management of foundries in Great Britain have awakened to the fact that they must, in order to safeguard their interest, seek some alternative methods of production should such an eventuality occur again.

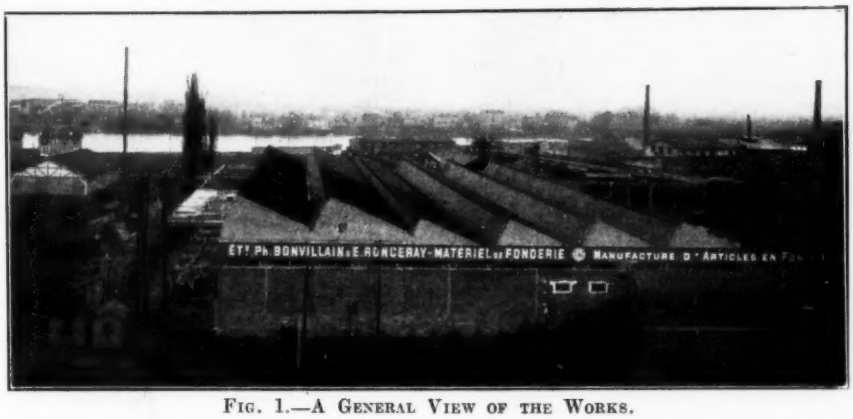

Fig. 1.—A General View of the Works.

Added to this, it seems that engineers generally are realising that as far, at least, as their foundries were concerned, they are far behind other countries: in fact, that previous to the outbreak of hostilities this country was purchasing the vast majority of their castings, which, after all, are almost an essential in every engineering shop, from the Continent.

The writer recently inspected an up-to-date foundry situated at Choisy-le-Roi, in the environs of Paris, so as to study first-hand their methods, not only of machine moulding, but also of sand-preparation, core-shop practice, metal pattern plate and stripping plate making, and their general foundry methods. The foundry visited was that belonging to Société Anonyme des Etablissements, Ph. Bonvillain et E. Ronceray, who are represented in Great Britain by the Universal System of Machine Moulding & Machinery Company, Limited, 97, Queen Victoria Street, E.C.4.

The foundry is very well situated, being placed between the main railway and the River Seine, and owing to differences in the levels of earth, advantage has been taken of these levels in the following manner:—All the raw material for use in the foundry is brought up to the high level by the railway lines, metal and coke are dumped into bins on the cupola platform, the level of which is brought up to that of the railway lines. The sand is conveyed in the same manner, and is dropped

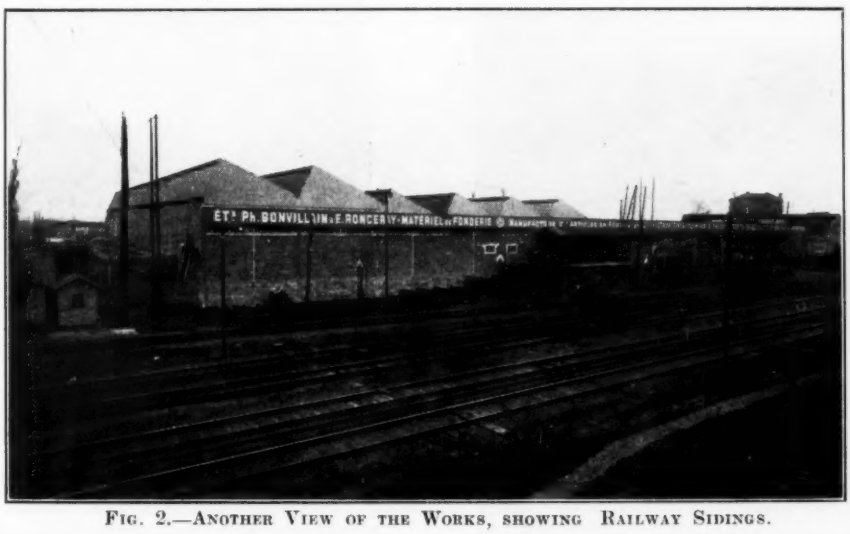

Fig. 2.—Another View of the Works, showing Railway Sidings.

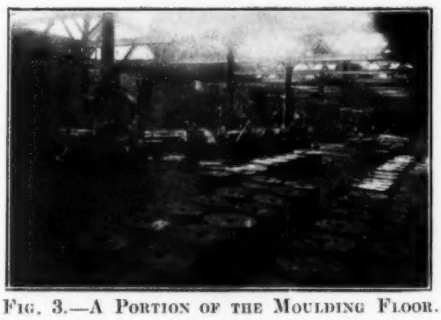

Fig. 3.—A Portion of the Moulding Floor.

Fig. 4.—The Machine on the Right is a Small Hydraulic Squeezing Machine, and on the Left an Assembling Machine which Pushes the Mould Out of the Box, enabling Casting to be Carried Out without Boxes.

from the bottom of the trucks into concrete bins, the bottom of which is on a level with the sand-mixing department of the foundry. The outlets of these bins are so arranged that they are within

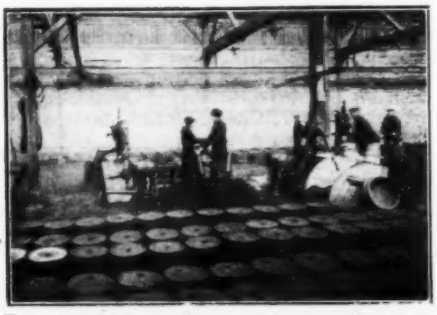

Fig. 5.—Another Portion of the Moulding Floor, showing Machine Equipment, Overhead Monorail and Assembling Machine.

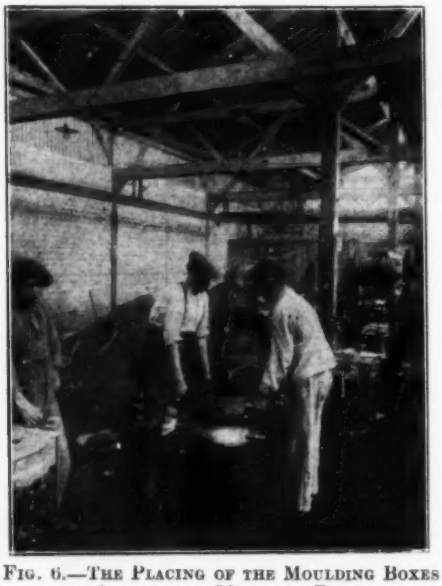

Fig. 6.—The Placing of the Moulding Boxes on the Assembling Machine, Prior to the Moulds being Closed on the Machine and Pushed Out on an Iron Plate Ready for Casting.

Fig. 7.—A Mould of 2½ in. dia. being Lifted from the Moulding Machine.

easy reach of the operators of the sand-mixing machines. It will be seen that the sand is delivered mixed and milled with only one handling.

The sand-mixing department is situated on one side of the foundry, and is well served with overhead monorails which bring the used sand and also returns the re-mixed sand to the moulding machines. (These monorails are of English make, being manufactured by the Vaughan Crane Company, Openshaw, Manchester.)

Being convinced that the Continental foundries excel in the preparation of their sand, a great deal of attention was naturally paid to this matter.

Fig. 8.—The Two Cupolas which Serve the Foundry. Each is Provided with Three Tap Holes

In this country, to-day, the machinery for preparing sand is generally reduced to the ordinary mortar mill and nothing else. In France, they use for old sand returning from the foundry, a rotative sieve which sieves the sand through, the pieces of metal, etc., falling into a separate compartment, to be cleared away afterwards. The

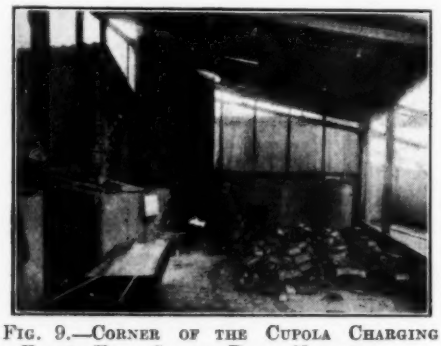

Fig. 9.—Corner of the Cupola Charging Floor, Each Charge Being Numbered.

sand, both old and new, is then placed in the required quantities into a sand mill, with rollers very light in weight, one of these rollers being flat, and the other with five or six grooves all round; the action being, that the light, flat roller rubs or kneads the sand and does not crush it, and

Fig. 10.—Roll-Over Machine Completely Rolled Over.

the grooved roller cuts or divides it up again. The sand is then put through a disintegrator which aerates and separates it. The result of this practice being that the sand is tough or strong, but at the same time open or porous. The argument

may be brought forward that the nature of the sand is different in France to that of Great Britain, but the writer feels sure that if we went to the same trouble as the Continental foundries with our sand we should be surprised with the result, and would be amply repaid for our expense and trouble.

The next feature of interest was the making of metal pattern and stripping plates and core-boxes without machining both for match plates and also split patterns. These plates were made very quickly and cheaply, and were absolutely accurate.

For making these pattern plates, Messrs. Bonvillain & Ronceray have patented a special set of pattern-plate appliances, enabling an average moulder to obtain not only simple pattern plates, but also most complicated ones, with, if necessary, core holes and stools, stripping plates where required, loose pieces and plugs, by starting with ordinary common wood patterns.

Fig. 11.—A Pair of Mounting Machines Making Brake-Shoes and Pattern Plate and Stripping Plate for a Vice.

With regard to the stripping plates, this concern believes that the most efficient and absolutely certain method of getting a perfect mould, which does not require patching, is by the use of stripping-plate methods. The old methods of making a stripping plate was most costly, owing to the fact that it was machined in the machine shop, and confined to flat joints or nearly flat joints. By the use, however, of this system, any average moulder can make a stripping plate for a flat or crooked joint, or for a simple or intricate casting. There is no fitting work, and the foundry is independent of the machine shop in this respect.

Cupolas.—These were of the suspension drop bottom type, being situated at one end of the

Fig. 12.—Showing Two Sides of Pattern Plate, and Casting for a Cistern; These were Made without Machining.

foundry. They are arranged so that the flow of metal is continuous in the following manner. The cupola is never plugged, but the flow of metal is regulated by a special valve in the blast pipe close to the belt, and the metal is forced through a ganister block inserted in the mouth of the cupola. It is an extremely clever method, and in the accompanying illustration showing the two cupolas, it will be seen that there are three tap holes which are part of the ganister block, acting almost as a receiver, and clean metal only being drawn from the cupola. The molten metal is carried away in ladles suspended from the monorail which runs all round the foundry.

Having explained the methods of preparation of articles required for the moulding machines, we now come to the moulding machines themselves. Contrary to the British and American practice, these machines are not worked by compressed air, but by hydraulic pressure, although the writer understands that these machines can be, by the inclusion of a small apparatus worked with compresed air, but the manufacturers advocate hydraulic pressure for the following reasons:—(1) Much smoother, and more even working. (2) Hydraulic power is more under control, because

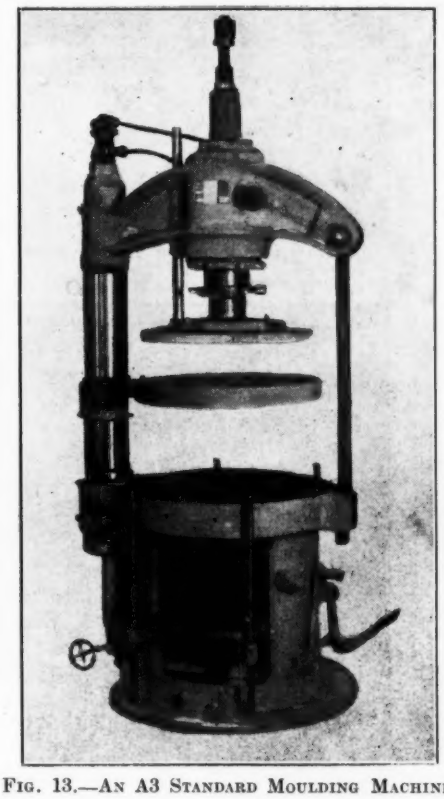

Fig. 13.—An A3 Standard Moulding Machine.

working with a certain weight on the accumulator all the power in the machines is felt, whereas with compressed air, there is nearly always a leakage, almost impossible to detect in the pipe lines. (3) Cost of upkeep and installation. (4) Low power required. The contrast between the working of hydraulic power and compressed air is very much marked, when it is stated that this particular foundry have 16 hydraulic moulding machines worked

Fig. 14.—Casting into Moulds Made without Boxes. A Flat Weight is Used to Hold the Mould Down.

by a 5-h.p. motor-driven pump which is not working for more than half the day. The power consumption when using compressed air would be very much higher than that taken by such a unit.

The types of moulding machines working vary according to the class of work on which they are employed. It is, therefore, proposed to give a brief description of the machines in the order that they are installed in the foundry:—

machine rams the top and bottom box in one operation, withdraws the pattern plate by means of a vibrator, closes the boxes on the machine, and then pushes out on a board the complete mould, thus enabling it to be cast without boxes. The

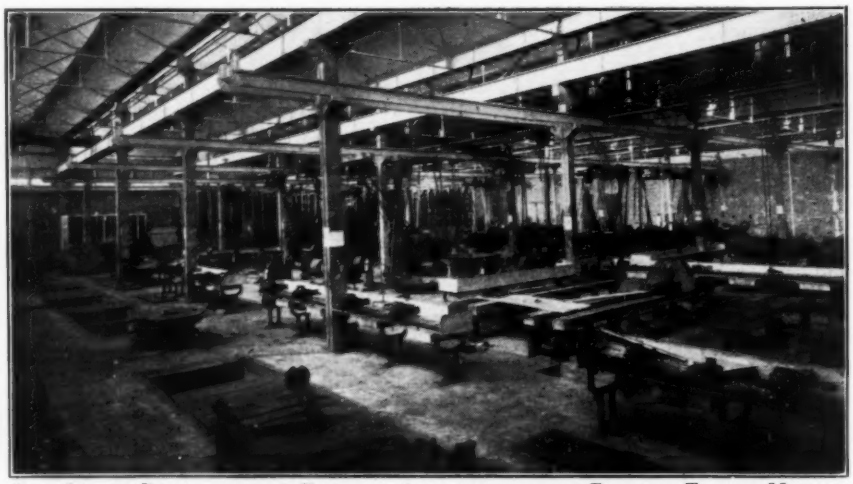

Fig. 15.—A Corner of the Erecting Shop, showing the Pits for Testing Moulding Machines.

Fig. 16.—A Corner of the Machine Shop.

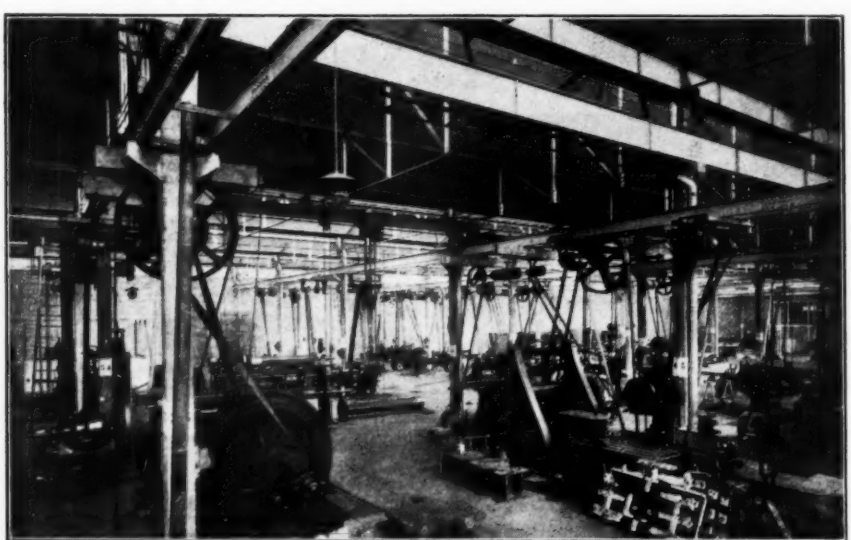

Fig. 17.—Another Corner of the Machine Shop, showing Machines in Operation.

D.F.A Machine. This machine is a most remarkable one, from the fact of its huge output. It is worked by two hands, one attending to the top flask and the other to the bottom one. The output on a low average would be 40 to 50 complete moulds per hour, with one machine, two unskilled men, and a size of mould approximately 17 in. by 12 in. by 3 in. to 3½ in. deep each side,

or 6 in. to 7 in. over all. It must be explained, however, that the D.F. 4 machine is only to be used for shallow work, consequently, on passing on to the next class of machine, it was noticed that entirely different methods were employed.

A.5 Machine.—This machine is employed for making small castings with a deeper draw than the D.F.4, and it also differs because it works with a split pattern and stripping plate, whereas the D.F.4 machine uses a double-faced plate. The manufacturers advise this type of machine, in order to work in the most economical method, to be employed in pairs with what is termed an S.A.5 assembling machine in between. The functions of the two moulding machines are to make the top and bottom parts, that is to say, one is working on the top, and the other on the bottom. The bottom part is then placed on the assembling machine, and any cores inserted, and the top box is then locked on the top of the machine. A hydraulic plunger with an iron plate on top is then pushed through both boxes, thus enabling the casting to be done without boxes, and at the same time guaranteeing accurate closing of the moulds, with unskilled labour.

On all the "A" type of machines, the same methods as described for the A.5 machine are employed. The "A" range of machine takes boxes from 10¼ in. round or square normally, which can be adjusted to accommodate boxes 14 in. by 14 in. to 21¼ in. round or square, or 21¼ in. by 14 in. rectangular normally, but which can also be adjusted to take boxes 22 in. by 32 in.

All of the above machines, in most cases, can be used in conjunction with the S.A. assembling machine, thus enabling the foundry to cast without boxes.

R. or Rotative Machines.—In order to facilitate the manufacture of very deep castings, the Company have devloped this series of machine, to work in conjunction with the "A" type of machines, the "A" machine being on the shallow side, and the "R" machine on the deep side.

As the whole "R" machine rolls right over, and the mould is drawn on the pressure plate, gaggers are eliminated, and cores very often left even to considerable depth in green sand in the mould.

The foregoing gives a rough idea of a few of the machines this Company make, but although the same ideas are carried practically right through, they make in addition several other types to suit varying conditions in the different foundries. A few of these could be classified as follows:—(1) *F.3.* and *F.4 Machines*, for working on shallow work in barred boxes, consequently, casting in these cases *with boxes.* (2) Various types of hand moulding machines, some of which are so constructed that they can be altered to power machines at a later date if the foundry wished to increase output. (3) *M.1 and M.2 Machines* takes boxes approximately 4 ft. 10 in. by about 5 ft., and so arranged that various shapes of boxes can be used and supported on the machines.

R.C.1 and R.C.2 Machines.—Large turnover machines giving sufficient pressure and space to ram a box about 6 ft. by 4 ft. 6 in. with very deep draws.

One thing which is worthy of note in connection with all these machines is the extreme simplicity of the machines and the operation of same. The operating handles and treadles being placed in the most convenient positions, the operator is able to get at any part of the box owing to the sides of the machines being perfectly free and open. Also the sand frame which is used when filling the box with sand so as to get a uniform depth is attached to the pillar of the machine, and is swung to one side when not in use. This frame is made adjustable to suit any depth of box within the range of the machines.

A further interesting feature noted was the moulding of the runner in the top box. In order to do this, a compressible rubber sprue is placed vertically on the pattern plate in the same manner as an ordinary runner peg used in hand moulding. The box is then filled with sand and the inlet valve opened admitting pressure to the ramming plate of the machine. In squeezing the sand into the box under this pressure, the rubber sprue is reduced in length but increased in diameter or width according to the shape of sprue being used. When, however, the pressure is released the rubber sprue springs out above the top of the mould and is easily removed, leaving a perfectly smooth runner.

Core-Shop.—Oil sand cores in this shop were the great feature, and the prevailing custom is to pick up the core (before baking) in the hand. The methods of mixing are very thorough, it being pointed out that the sand, oil and agglutinant must be thoroughly well mixed in order to get the desired result mentioned above. For this purpose, the Company make a small machine closely resembling a bakers' dough-pan, in which two helical blades work by means of cogs, and the sand and oil is turned over and over, at the rate of about 50 revolutions a minute, and a complete mixing of the various ingredients is thereby effected.

The proporietors of this foundry extend an invitation to all bona fide foundrymen to visit them, and correspondence on this subject should be addressed to their London house.

THE INFLUENCE OF COPPER ON IRON AND STEEL.—An article on this subject appearing in a recent issue of "Chemical and Metallurgical Engineering," was summarised by the authors, Messrs. E. A. and L. T. Richardson, as follows:—1. Copper added to iron produces red-shortness over a certain temperature range. The degree of brittleness and the temperature over which it occurs increase with an increase of copper content. It is believed that this brittleness is due to an intergranular film of copper or an alloy or compound of copper. 2. The red-shortness due to copper is removed by the addition of manganese or chromium, but the amount necessary depends on the copper content. This observation explains why copper added to iron causes red-shortness, while it does not cause red-shortness in steel unless added in excessive amounts. 3. The addition of copper up to at least 3.50 per cent. apparently does not impair the cold-working properties of the alloys. Beyond 2 per cent. of manganese the alloys become too brittle to work, while with more than 2 per cent. chromium the alloys become hard and tough.

THE INDUSTRIAL LEAGUE AND COUNCIL.—The annual report of the work of the Industrial League and Council indicates that during the twelve months under review all the great manufacturing centres in the United Kingdom have been visited by emissaries of the organisation. Active branches are in operation in Manchester, Leeds, Birmingham, Deptford, Eastbourne and Southwark, and other towns in which committees are being formed include Leicester, Bristol, Portsmouth, Coventry, Glasgow, Hartlepool, Blackburn, Walsall, Halifax, Bedford, etc. The number of meetings which have been held and addressed run into four figures, and it is interesting to note the character and variety of organisations that have appealed to the League to provide lecturers on industrial subjects. It is, per haps, an indication of the growing interest which is nowadays being manifested in economics by all sections of the community. Fifteen conferences of a national character were held, and were attended by 700 employers, 60 employers' associations, 800 trade unionists and 460 delegates from trade unions, representing a membership of one and a-half millions. It is undoubtedly a healthy sign to find so many employers' organisations and prominent trade unions evincing an active interest in the objects of the work of the Industrial League, and it encourages one in the belief which is beeginning to obtrude from the shadow of industrial unrest, that both employers and employed are more and more realising that the prosperity of industry is a matter of vital concern to all engaged in industry, and that only by co-operation can each ensure their individual and collective well-being. It is to be hoped that as a result of the success achieved in the course of the last 12 months the Industrial League will be able to carry its work still further, and will receive a steadily increasing volume of financial and active support.

XUM

The Foundry Technical Institute, Falkirk.

Founded in 1918 by a group of ironfounders in the Falkirk district, the Institution exists for the purpose of furthering the study and application of scientific methods to foundry practice in general and to that of cast iron in particular; to that end, laboratories have been equipped with modern appliances for carrying out chemical, physical, mechanical and other examinations of materials, products and processes and also for the prosecution of original research.

There is also laboratory and lecture room accommodation for teaching purposes in connection with the training of apprentices and of young men who aim at becoming managers and leading hands in the foundries. It is realised that the increasing demands upon foundries for better, stronger and more intricate castings, and the keen competition of foreign nations can only be met by the adoption of scientific methods under the control of trained men.

The work of the Institute is divided into three main sections or departments.

The first section is purely local to the Falkirk district, but the other two may extend to the whole industry. In connection with the training section a carefully graded and systematic course of study has been in operation with the approval and co-operation of the Educational Authority for the past two years, and a number of young men are pursuing studies in preparation for the higher and specialised courses in metallurgy and iron-founding.

In addition, there are special courses of lectures on foundry subjects for foremen and older men, who may not have had opportunities of following a systematic course of study. These lectures have proved most successful, being attended by a large number of men anxious to improve their positions.

The Second Department—examination of materials, products, processes and technical matters—has so far been developed to the largest extent, and has constituted the major portion of the Institute's activities. It has proved of very considerable value to those members who have availed themselves of the facilities which the Institute offers.

It may be of interest to state briefly the nature of a few of the questions which have been referred to the superintendent during recent months, as indicating the scope of the work included in this department. The great importance of the economical use of coke, and all that pertains to the production of heat for melting and treating metal in foundry practice, led the Management Committee very early to undertake an inquiry into the quality and characteristics of the numerous brands of coke used by the members.

A very large number of samples were submitted to exhaustive chemical, physical and other examinations, the results of which gave information of great value to the users of coke. Inquiries on similar lines are presently proceeding in regard to moulding sand, blackings and other materials.

The assistance of the Institute has been sought in solving many difficulties arising in the foundries, and a few examples are here given.

Large quantities of unfamiliar brands of pig-iron are now being brought into the foundries, and this has given rise to trouble in some cases owing to the heterogeneous nature of consignments. A foundry had to scrap a very large proportion of the day's cast owing to excessive hardness and brittleness. Investigation elicited the fact that a brand of foreign iron had formed a good proportion of the charge, and this iron was very variable in composition, and especially low in silicon content; this, coupled with the fact that a large percentage of light scrap had been charged, some of which was burnt and rusty, had reduced the silicon percentage to such an extent that all castings up to ¼ in. in thickness chilled right through and were practically white iron. The addition of soft siliceous iron and reduction of the proportion of scrap led to an immediate disappearance of the trouble.

A case of general interest was dealt with a few months ago, in connection with the output of a cupola. In this case, the low melting rate necessitated reducing the quantity melted or very late finishing of the day's cast. The design and arrangement of tuyeres seemed to be satisfactory and the tuyere of ample size, but the pressure of blast employed was very high, and general appearances pointed to both pressure and quantity of blast being excessive, analysis of the waste gases confirmed the surmise that too much air was being blown in. The reduction of the quantity of blast effected an immediate improvement. A volume gauge was installed and several analyses of the gases made until the furnace eventually melted well up to its capacity, after which no difficulty was experienced in getting the cast through in good time.

An interesting case was dealt with, where, consequent upon the use of unsuitable blast, the coke consumption was excessive. The tuyere area in this instance was very small, but the air was blown in under excessively high pressure, so that the actual quantity entering the furnace was much in excess of that necessary for complete combustion of the coke charged, nevertheless, analyses of the gases gave the anomalous result of an excessive proportion of carbon monoxide indicative of incomplete combustion and at the same time large proportion of free oxygen. In this case, the air travelled through the furnace at so great a speed that it did not remain in contact with the coke sufficiently long for combination of the carbon and oxygen to be effected.

By increasing the tuyere area very considerably and reducing the blast pressure a marked improvement was effected and at the same time better metal obtained, with a saving of about half a hundredweight of coke per ton of iron melted.

The importance of proper blast distribution is illustrated by the case of a large cupola designed to give a large output per hour. The furnace had been very carefully designed and provided with a blower of suitable size, driven at a carefully adjusted speed, to give the proper quantity of air at a moderate pressure. Melting proceeded satisfactorily for the first hour or so, but gradually slowed down, until after a couple of hours it scarcely melted at all, and an incrustation gradually formed in front of the tuyeres which eventually spread over nearly the whole area of the furnace. This trouble lasted for some time, but eventually it was found that the blast was creeping up the sides of the furnace and not doing its work, as was shown by the composition of the gases. The quantity of air entering the furnace was measured by means of a volume gauge and found to be very little in excess of that necessary for complete combustion of the amount of coke used. The trouble was eventually removed by increasing the weight of charges and re-arranging the tuyeres so as to give a good distribution of the air. The furnace afterwards melted satisfactorily and above its rated capacity.

Trouble of a somewhat different nature which has arisen in several foundries has reference to the cupola being dirty and difficult to draw, owing to the formation of heavy slags. In one such case, the trouble arose through whinstone having been consigned as limestone; obviously this produced a highly siliceous slag which was not only of low fusibility but caused a considerable melting loss, as the only bases available for fluxing were oxides of iron and manganese oxidised from the metal.

The Third Section—original research—has not so far been fully developed owing to the staff being occupied in other directions, but a scheme for a very exhaustive research on cupola reactions has been formulated and a furnace 36 in. in diameter specially designed for the purpose is now almost complete, and it is anticipated that results of the greatest importance will be obtained from this investigation.

It is generally recognised that the nature, size and distribution of the graphite particles in cast-iron has a very decided influence upon the strength and other properties, but no definite, reliable data as to the extent to which this influence is exerted is available, and an investigation has been commenced for the purpose of determining the exact influence of graphite carbon under various conditions.

An American View of the Brass Industry in Great Britain.*

By Paul M. Tyler.

The manufacture and utilisation of brass comprise an important group of industries in the British Isles. According to the most recent census (1907) the output of brass and copper manufactures in the United Kingdom was valued at nearly £15,000,000 and over 20,000 persons were employed in the industry. For comparison with American statistics, the output of finished brass goods, amounting to £7,000,000 and employing 2,000 workers, should be added to the above figures. The data indicate that the volume of the British trade in that year was slightly more than one-half that of the United States.

It is commonly recognised that the brass industry in both countries has expanded greatly since 1907 and especially since the outbreak of the war.

For the purposes of this discussion the industry can be most conveniently divided into three main branches, viz. :—(*a*) Cast products; (*b*) rolling mill and extruded shapes; (*c*) other products.

Since the conditions of raw material supply for each of these industries is slightly different, this factor does not require separate discussion. It may be mentioned, however, that both copper and zinc must be imported into the United Kingdom and that London prices for these metals since the war have averaged a little higher than New York quotations. The British copper supply comes chiefly from the United States and must sell at a slightly higher price, while an increasing supply of spelter in late months has been again derived from European sources with the prospect that as soon as the Belgian works regain their pre-war capacity, zinc prices in London may be a little lower than American prices for this metal. The British zinc smelting industry has practically proved its inability to compete with external sources of supply. European stocks of scrap brass have diminished somewhat during the past year and are now held chiefly by consumers and middlemen, but they still form a fairly important feature of the present situation.

Increasing Standardisation.—Specialisation in manufacture has made some progress, especially since 1914, but British foundries generally make too wide a range of products for the most efficient utilisation of their plants. This is due in part to the inherent inclination of the British manufacturer to cater to as great a variety of buyers as possible rather than to be solely dependent upon a fewer number of large consumers. Perhaps of equal significance is the practice of engineers in the British Isles to make individual specifications in their orders which necessitates the manufacture of supplies to individual order rather than in bulk. The latter difficulty has now in large part been done away with as far as hydraulic fittings are concerned, since the general adoption of the Imperial Joint Committee of Water Works Regulations standard. Most of the hydraulic fittings are brass, while most of the steam fittings, especially for high pressure service, are made from gun metal, the Admiralty specifications for which are 88 per cent. copper, 10 per cent. tin, and 2 per cent. zinc although steam fittings for other consumers are more generally made from a cheaper mixture containing less tin and more zinc.

As regards miscellaneous castings, the activities of the Association have resulted in a marked reduction in the number of designs produced by individual firms. The associated firms have come together and eliminated many competing lines by means of agreements and have attained a better specialisation in output. Unnecessary patterns and designs for which the demand is comparatively small have been discontinued. One firm, for example, which formerly listed 22,000 different patterns in its catalogue, reduced the number in 1919 by 75 per cent.

Raw Material.—British foundries almost without exception buy their brass in the form of ingots which are prepared by separate firms. These ingots are made chiefly from scrap, and except for special work little attention is paid to the analysis, the brass founder generally working by rule of thumb. The ingot makers have a large variety of scrap to draw upon and are able to supply ingots at low cost. While the material varies somewhat in composition, it is deemed satisfactory for all classes of ordinary work.

Melting.—Throughout the Birmingham area pit furnaces are used almost exclusively. For ordinary foundry work plumbago crucibles holding about 60 lbs. of metal are employed. Gas firing has been tried at several foundries, but has been found more costly than coke, which is now used in all the foundries. Since pouring is done only at the end of the day, there is no reason for hastening the melting with the consequent risk of cracking the crucibles. Birmingham gas coke is high in ash and sulphur, but since it costs only 30s. to 35s. per ton, delivered at the works, as compared with over 60s. for metallurgical coke, it is more economical. On account of the slow heating, the life of the crucibles is fairly long, a crucible lasting almost invariably for more than 20 heats, and frequently as many as 40 heats are obtained from one pot.

Rolled and Extruded Shapes.

Most of the rod now used in England is extruded, the chief consumption being for capstan lathe work. Extruded rods, however, are not used for making wire, since the British wire drawers specify rolled rods and frequently make them in the same establishment. The extrusion process in England is almost wholly a war development and the output increased by fully ten times during the war period. Due to accumulation of stocks, the trade has been very slack since the signing of the armistice, and while a few plants have remained in operation it is doubtful if many of them have more than paid expenses. The trade is not organised and little export business is done, although the two firms which dominate the industry are conducting a fairly ambitious campaign of education to introduce their products at home and in Colonial and South American markets.

Sheets, Rods and Strip.—Yellow metal is largely made up in sheets, and is invariably hot-rolled. The distinction between the composition of "yellow metal" and "brass" is not clearly defined, but in England yellow metal is understood to mean a brass containing approximately 60 per cent. copper and 40 per cent. zinc (Muntz metal). It is rarely, if ever, sold on specification as regards impurities, whereas the rolled brass trade is accustomed to rigid specifications covering the allowable limits of lead and iron, as well as the content of copper and zinc. Whereas the metal used for brass foundry work will ordinarily contain in the neighbourhood of 57 per cent. copper, with varying amounts of impurities, rolled brass will generally contain 61 per cent. of copper. Cartridge brass is a special alloy containing 70 per cent. copper and 30 per cent. zinc.

The pre-war output of cold rolled brass in England was between 15,000 and 16,000 tons annually, but during the war production reached 60,000 tons. Due to the difficulty of getting supplies and new machinery to replace that which had been worn out during the war, the British rolling mills were unable to meet the requirements of their customers until within the past four or five months. They are now able practically to meet the demands of their pre-war markets and expect within a year to have a surplus of some 300 tons a month which will be available for new customers. When plant renewals now under way are completed this amount may be increased by from 500 to 600 tons a week.

British brass rolling mills are small. The diverse character of the requirements of their customers has prevented the application of quantity production methods. For example, there is practically no standardisation of the widths of strips. An effort is being made through the Cold Rolled Brass and Copper Association, which comprises most of the manufacturers, to bring about a better standardisation of specifications. A little progress has been made, but there is slight chance of the British establishments being put upon the production of bulk lines to the extent that American mills now operate, since the British manufacturers believe that their chief advantage in outside markets is their ability to adjust their plants to the production of specialities.

Melting.—The foundry practice in connection with the rolling mills is not greatly different from that in plants devoted to making brass castings. Melting is done in pit furnaces, using coke, but the crucibles are larger, holding from 120 to 200 lbs. of metal. Greater care is taken in the selection of raw material and practically the only scrap used is that made in the same plant. Very little brass is bought and this is selected scrap or ingot, which sells at nearly the price of the constituent metals. Fully 60 per cent. of the brass used in British rolling mills is made direct from virgin metals.

Brass Wire.—Wire drawing is done by several firms in the rod rolling business, but is also carried on in separate establishments. The total output is less than one-fourth the tonnage of the brass rolling mills, and can be taken at approximately 10,000 tons annually, this figure covering all classes of non-ferrous metal wire, including brass, copper, phosphor-bronze, nickel-silver wire, etc.

Generally speaking, the equipment of British brass wire works is antiquated and inefficient. Continuous

* Extracted from a recent issue of the "Iron Age."

wire drawing to the extent of six blocks in series is conducted at some establishments, but is not general. Prices and costs are practically as high in the United States, while the output is not greatly in excess of home requirements although a limited export business is done, chiefly with British possessions. Wire goods are made in England in considerable quantity and sell chiefly in foreign markets, but the advantage of the British manufacturers of these more highly finished articles seems to be rather in the drawing of fine sizes and weaving, etc., than in obtaining cheap wire of the coarser gauges.

Other Manufactures.

A wide variety of specialities of all kinds are manufactured in various localities in the United Kngdom, but by far the greater part of these are manufactured in the Birmingham district. Most of the plants are comparatively small, and the employees are not organised, but the male workers are affiliated with the union of the engineering trades. In general, the developments during and since the war have not been important. As in other branches of the brass trade, there has been no lack of orders and all the establishments have been kept occupied to full capacity. The increased demand for electrical appliances and the growth of the automobile industry accounts in part for the greater activity. A great many pressed metal articles formerly imported from Germany are now being made in England, but the only important new line is the manufacture of bronze powders, which are now being produced in fair quantity for home consumption and export, whereas prior to the war none was made in the United Kingdom.

Comparison of British and German Brass Works.—A delegation of British brass manufacturers visited a number of plants in the occupied area of Germany in the summer of 1919. The delegates undertook their mission with the feeling that the German manufacturer was well ahead of them in manufacturing methods, but they reported that the one advantage the Germans had was due to the smaller varieties of articles produced by each manufacturer which enabled a greater concentration of output and a larger turnover, combined with that careful attention to the manufacture which is characteristic of the German.

The German casting methods presented the greatest divergence from British practice One practice generally observed in German works, but rarely employed in England, was to put the moulds into an oven as soon as they are made and dry them there for 24 hours. The moulds when cored up are placed on top of each other forming a pile 3 ft. or 4 ft. high. They are bolted together and then laid on end for pouring in the usual way. It was found common practice in the German works for the castings to be cut off the ridges when cold by means of a sprue-cutting machine. In one works where hand moulding was in progress the sand was compressed in the moulds by means of a metal ball about 7 in. in diameter and weighing some 50 lbs. It seems that such practice might insure a more regular pressure for work that does not vary too much in height.

The German melting furnaces conform more with American practice, although both pit furnaces and tilting furnaces were observed. It was remarked with some surprise by the British visitors that in certain plants pots were used only as ladles to carry the molten metal from the furnace to the moulds. Both oil and coke-fired furnaces were in use.

The British visitors were convinced that greater attention was paid in the German plants to the production of sheet brass than in their own country. The utmost care was noted in removing by chemical and mechanical means all oxides and foreign matter from the surface of the metal before it entered the rolls, with the result that a much better and finer product was secured. It also seemed that the slitting of the sheet brass was done very much better than in England, greater accuracy and cleaner cut edges being obtained, which results in a minimum of waste in working up.

The Rapid and Economic Repair of Castings.*

By C. W. Brett, Managing Director, Barimar, Limited (Welding Specialists).

Time was when fractured or worn machinery inevitably meant new machinery; when a damaged metal component meant the purchase of a new component. Replacement was, then, the sole means whereby disabled machinery could be restored to commission. Those days are now past. Replacement, in point of fact, is not a repair at all, but the part purchase of a new whole. Repair consists in taking a broken or worn member and so treating it that it is rapidly and economically returned to full service, yielding precisely its original 100 per cent. efficiency.

Now, from this point of view, the direction from which adequate aid may be expected is easy to anticipate. There exists only one method—subdivided into several processes—by which all kinds of industrial metals can be homogeneously amalgamated, soundly built up, or fabricated, and that is by the employment of what is commonly, though inaccurately, designated autogenous fusion.

Certain repairs can only be suitably dealt with by the use of oxy-acetylene, others by the electric arc; others, again, by the employment of thermit, the oxy-hydrogen flame, or a special metallurgical process which resembles, though it actually is not, welding. Each of these media of repair has its specific use, and selection is a matter which must be left to expert discretion. This is a fact that cannot be too forcefully emphasised: no welder can hope to handle general repairs unless he is master of all the processes. A great deal of harm has been done to valuable machinery, and welding progress has been materially hindered, by those who rely upon one method. If no actual need for more than one process existed, other processes would not have been perfected.

Carefully collected statistics prove that 95 per cent. of all causes of mechanical failure or breakdown are remediable by the skilful employment of scientific welding—whether they be due to fracture, wear or damage in cast-iron, wrought-iron, steel, aluminium, bronze, or gun metal; whether the part or member weighs 4 tons or 4 ozs.; whether fixed or movable, old or new, rusty or bright, short of pulverisation, or shattering beyond recognition, all breakages or injuries can be made good by the competent welder using proper equipment.

Welding is a scientific and highly technical process, which demands expert knowledge of metallurgy, vast experience, and operative skill of a high order. The following analysis of recent investigations into this matter may serve to show the importance of training :—

	Sound.	Unsound.	Useless.
Welds made by journeymen engineers—50	10	14	26
Welds made by trained welders—50 ..	46	3	1

Among the defects most commonly observed were "cold shuts," hard beads, oxidation, flaws due to improper thermal preparation, cracks due to careless cooling, faults arising out of improperly controlled contraction and expansion, wrong admixture of gases, and the use of an unsuitable "feed-rod."

It is, of course, a perfectly simple matter to unite two pieces of metal by fusion, given the proper equipment. But mere junction is not necessarily welding. Radio-metallographs, obtained by the employment of X-rays, prove conclusively that welds that have every appearance of soundness are, in not a few cases, wholly unfit for service. External appearances are notoriously deceitful, but in no circumstances more so than in welding, where the laboratory is the only reliable test.

Although welding practice bristles with unseen and unsuspected difficulties, and particularly so in the hands of inexperienced operators, there is another side of the question. Given the requisite operative skill and expert guidance, backed up by a veritable battery of up-to-date appliances, there is no doubt that it is by far the most important factor in the economic maintenance of machinery of all kinds. In most cases the actual cash saving may be reckoned as 50 per cent. of the cost of replacement, while the saving in time is enormous. It is on record that a large repair was done to a marine engine in five days—without dry-docking the ship or dismantling the power unit—while a replacement would have entailed a delay of upwards of six months. In another instance, not only was an immense saving of time effected, but the cost of the weld was £300 less than the figure tendered for replacement. Facts and figures of this kind leave little room for debate as to the value and utility of autogenous fusion and kindred processes.

*Extracted from a recent issue of the "Gas World"

Moulding Rudder Castings.

By Ben Shaw and Jas. Edgar.

In beginning the formation of the mould for a rudder yoke, whatever method may be adopted must have as a preliminary, the preparation of the bed so as to define accurately the shape. In many foundries the prevailing practice conveys the impression that preparing the bed, as it is termed, is of comparatively little importance. Let the moulder, however, examine a number of large castings after they have been machined off in the machine shop, and the truth will dawn upon him that many difficulties with which the machinist has to contend are caused by the inaccuracy of the bed upon which the pattern had been laid. It is certainly impossible in the present instance to construct a pattern which would be absolutely rigid, hence any inaccuracies in the preparation of the bed would be present in the casting. Many such examples could be mentioned, but it is sufficient to prove that the utmost care is essential in preparing a sandbed to receive a pattern of this character. Whether the pattern is to be bedded into the foundry floor, and the work cast in that position, or prepared in a moulding box, is of secondary importance, as the prepared bed is essential in each case.

If the major part of the mould is made in the floor before the bed is constructed, it must be decided which side of the work is to be cast down. The same applies if prepared in boxes and cast on the flat. The illustration, Fig. 1, shows the method adopted when the boss as the highest point is cast up. The making of the bearers is usually undertaken by the foundry doing the work, but

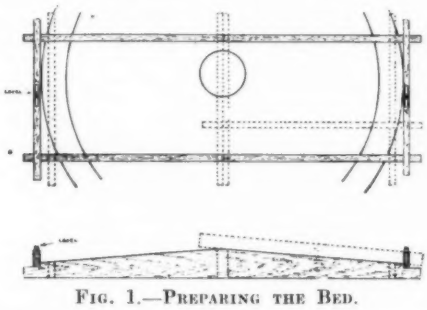

Fig. 1.—Preparing the Bed.

sometimes firms sending patterns, forward guide bars for the formation of the bed. These are, however, few, and it is better for the foundry to determine their own methods and make tackle accordingly. The two bearers or guide bars shown should be cut out together, being prepared as one, so that they will be similar to each other in every respect, the rake, of course, being obtained from the drawing and not from the pattern. The steps at the ends provide a guide for squaring and levelling, as indicated in the sketch. It simplifies matters to prepare roughly a level bed, on which the guide bars are set parallel to each other, using the parallel straight-edge against the steps to determine whether they are out of winding with each other, and a square to prove the steps at right angles to them. When the guide bars have been set satisfactorily, sand is rammed between and about them and strickled off to coincide with the guides. If it is decided to cast the rudder yoke in the reverse way, then the same procedure can be adopted, but the bearers would have the rake in the opposite direction.

Another method of preparing the bed is sometimes adopted, and is illustrated by the dotted lines in Fig. 1, the use of which necessitates the preparation of a level bed, and since the bearers must be set accurately from the centre, the services of the pattern-maker are usually requisitioned to reduce the possibility of mistakes. While both these methods are adopted in general practice, the former method provides the safest means of ensuring a reliable bed. Now this bed is really formed to receive the plate portion of the pattern, hence much of the bed will need to be cut away. In doing so, it is comparatively easy for the moulder to get a twist on the pattern, and to avoid that difficulty, it is advisable to strickle out a shape with trammels corresponding to the shape of the blocks at each end of the pattern and the boss at the centre shown in Fig. 1. Then, by lowering the pattern over, and setting it to coincide with these lines, an impression of the projecting ribs can be made, which will give a sufficient guide for cutting away to ensure the pattern plate coming into close contact with the pre-

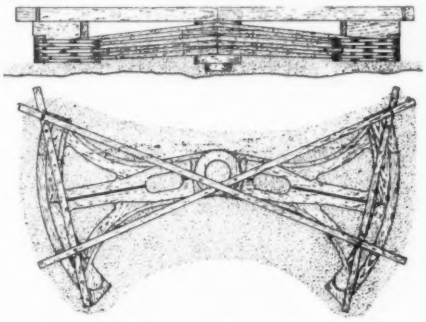

Fig. 2.—The Pattern Bedded Down.

pared bed. All the sand can be cleared away from the outside, to enable the moulder to bed the pattern so that the inner portion will more nearly represent the requirements of the mould. The outside can be easily rammed up once the pattern has been bedded down properly. Bedding in a pattern is at any time a gradual process, but when the pattern is fragile greater care is necessary, because that degree of hammering resorted to in stronger patterns must be avoided as much as possible. When the special facing-sand has been applied, and the pattern finally bedded down, the stiffeners on the pattern can be removed, and weights lowered at suitable places on the pattern, to maintain its position while the sand is being rammed about it. The lightning holes on the plate can be used to ensure that the density of sand about the under side is sufficient, in any case the bed must be broken at these places to ram up the sand, to form a joint as near to the surface of the plate as possible, provided the work is to be cast in the floor. Fig. 2 shows a plan of the pattern in position, having the stiffeners attached for increasing its rigidity. These successfully reduce the strain from the centre of the pattern, and assist the moulder during the time of bedding-in. The elevation in Fig. 2 shows another view of the relation of the pattern and the stiffeners, and illustrates the pattern bedded-in when the boss is the highest position, and the bottom portion of the mould is made in the foundry floor. An enlarged view is shown in Fig. 3.

In providing a steel casting of this description, there is much difference of opinion as to the best position for casting. The method shown in Fig. 2 is more general, because the gradient helps the

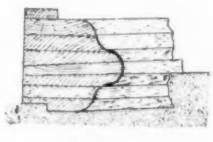

Fig. 3.

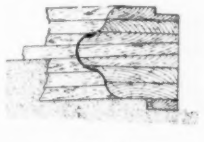

Fig. 4.

metal when poured at the boss, but such a metal provides a colder metal to the chain guides, which are of comparatively thin metal. Many moulders prefer to supply the hot metal to the thinner portions when circumstances will permit, and as long as the pressure is sufficient a good casting will result. When a drag box is used, and it is better that one should be used if it is convenient to do so, then the mould can be turned on its side and cast satisfactorily in that position. If the moulder prefers casting by way of the chain guides, with the bottom a fixture in the foundry floor, then the preparatory bed must be the

reverse to that shown in Fig. 1, and the pattern bedded-in similar to the enlarged part, view Fig. 4, with the chain guides as the highest plane. When the pattern has been bedded-in and the internal portion of the mould rammed satisfactorily, making a joint up to the centre of the curved edge of the lightning holes, the outside ramming can be proceeded with. With the exception of the boss, which should have about 2½ ins. of special facing-sand about it at all other points, a thickness of 1 in. to 1½ in. will suffice; so that at all parts of the mould with which the molten metal comes into contact, provision must be made to secure a good casting by using special facing-sand. Ram up the sand about the outside of the pattern, and form a joint. From the top of the chain guide cores cutting it down to the thinner part for the shackle, and continue the joint along

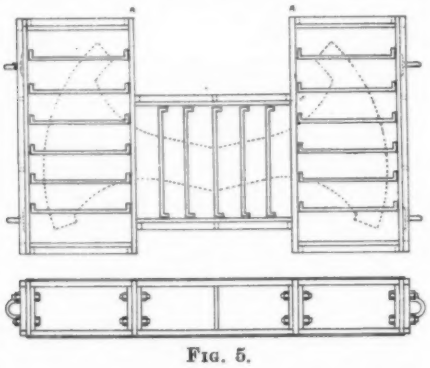

Fig. 5.

the top of the ribs and the boss. Then a mean line may be taken between the surfaces of the boss and the chain guides for the cope box, and the joint dropped to correspond with this at a distance from each side of the boss, and raised from the chain guides to a level joint for the top box. The joint could be made flush with the surface of the chain guides and gradually dropped from the boss to this level, but a special deep cover box would be required, and the lift, if the joint is made flush with the surface of the boss, would be more than is justifiable under the circumstances, hence by taking a position approximately half of the difference between the two an advantage is secured.

Many jobs of this character can be satisfactorily made in roll-over boxes, the principal difficulty being the provision of these boxes. So many foundries have made a practice of making solid boxes, and stocking them for future use, lumbering their valuable space with tackle which is rarely used, that one wonders at the lack of system which prevails. Instead of making solid boxes which do not lend themselves to any variation, it would be preferable to standardise boxes in sec-

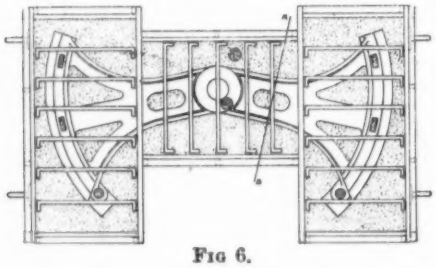

Fig 6.

tions, sides, ends and bars. They take up much less room, and boxes can be built up in a short time to meet requirements. With a number of convenient-sized sides and ends in stock, boxes can be so arranged for various classes of work, that little additional tackle or connecting portions are necessary. Such an example is illustrated in Fig. 5. With the exception of the connecting bars AA, which should be made to suit the work in hand, the box would very easily be formed from stock, and while it would be necessary to strengthen the box when required to be lifted, by clamping a couple of bars across, a useful box is produced, and unlike the solid boxes which are costly, it can be separated and returned to stock with more prospect of being useful in forming future boxes. In steel foundries moulding boxes form one of the principal features of the equipment, and to run the foundry economically just as much attention is required for this particular form of equipment as is usually applied to other forms. Sides, ends and bars can be classified, and tabulated list kept in the foreman's office where it would be of service in determining the more suitable parts for the construction of box parts to accommodate more of the work which comes into the average jobbing foundry. The use of the roll-over boxes gives more variation to the method of casting, and the moulder has less difficulty in obtaining an impression of the bottom of the mould such as will secure more regular density to the rammed sand. When a drag box is used for a rudder yoke, and the mould is to be filled on the flat, then a false part will be required, or, as is more general and answers a similar purpose, the pattern is bedded into the prepared bed and a joint made similar to that shown in Fig. 4. If it is desired to cast the mould by way of the boss, then after applying parting sand, the drag box is lowered over in an upside down position, and with special facing-sand applied about the pattern, the whole is rammed up to the bottom of the box part. Set a number of screw eyes into the pattern and wedge through on top of these bars to prevent any movement of the pattern when lifting, then roll over the box. Make up the joint, as previously described, and prepare to receive the top box.

Fig. 6 shows the top box set into position, but to ensure a clean lift in the top box, it is better to set in flat grids between the ribs and at each side of the boss. Such a grid is shown in Fig. 8, having three staples cast into it. When a bottom box part is used, it is desirable that grids should be used in both top and bottom, as it is a more reliable form of strengthening the formation of the mould. Make a bedding of special loam-facing, set in the grids, lower over the top part and secure the grids to it by means of S hooks, either directly to the top of the box bars if they

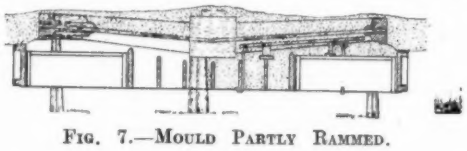

Fig. 7.—Mould Partly Rammed.

are convenient, or to a bar passing over the surface of the box bars. It is necessary to pack and wedge between the grids and the bottom of the box bars to render any movement very improbable.

In casting with the boss as the highest point, one of the best means of pouring the job is by supplying the molten metal to the bottom of the boss, and carrying sprays from the gate shown at the side of the boss in Fig. 6 to the plate at each side. When this method is adopted it is advisable to either secure a specially prepared runner from those firms which specialise in their construction or have one prepared in advance on the premises. It should be formed inside a block, and set into the bottom part of the mould while ramming up; the hole passing through the block being U-shaped at the bottom, one end of which comes into contact with the bottom of the boss pattern, and the other and longer portion terminating at the joint of the mould. Separate pieces can be framed and set into the mould in a similar manner, and connected with the main runner to form the sprays for the plate.

The connection between the hole in this block at the joint, and the surface of the top box, can be assured by setting a gate stick of sufficient dimensions, and surrounding it in the course of ramming with special loam-facing of a highly refractory nature. The same applies to the risers, which are shown on the top of the boss and at three places on each of the chain guides. With the exception of the riser on the top of the boss, and those on the shackle ends of the chain guides, which assist in feeding the casting at these parts, the risers shown are desirable for preventing air and gases being imprisoned in the extremities of the mould. There is no hard-and-fast rule in determining the method of running a job, each design requires special consideration, and successful

results are obtained by different methods in districts widely separated. Experience and commonsense are the main factors in solving these difficulties.

When the gates and risers have been fixed, the ramming-up of the top box can be proceeded with, and as there is no likelihood of contraction difficulties in this casting, hard ramming can be resorted to without fear. It is better, however, to provide a cinder bed beneath the plate at the bottom, as shown in Fig. 9, and connected with the top by way of the lightening holes in the plate. An elevation of the mould is shown by the illustration, Fig. 7, the left side of which shows the mould fully rammed up, and incidentally the relation between the top bars, the grid and the pattern. The section on AB of Fig. 6, and shown by the illustration, Fig. 9, gives another view of the grid with packing pieces wedged in to make it rigid. It also represents the joint of the mould formed to equalise the lid in the top box. The ramming up completed, draw the gate sticks and

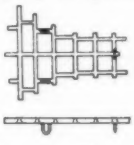

Fig. 8.—Guard for Top Lift.

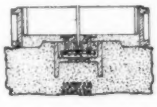

Fig. 9.—Section of Mould on A. B. Fig. 6.

lift the top box. Providing the inside of the ribs on the pattern have the necessary taper, a good lift will result; roll over the top to be more convenient for slicking and blacking. Return the drag portion and swab the sand well about the pattern, to which should be attached the stretchers previously used when bedding-in. These are not so much used to safeguard the pattern, a very necessary procedure, but to stiffen up the pattern and thus render its withdrawal more easy. The pattern in itself lacking rigidity would tend to bind during the time of lifting, and an unsatisfactory result would naturally follow. Both top and bottom parts of the mould require to be carefully made and slicked off, all sharp corners rounded, and a taper depression made along the joint. When sharp corners are essential, it is very necessary that they should be strengthened by inserting a plentiful supply of moulders' brads.

At the junction between the boss and the plate or web, where the difference between the thickness of the metal is so great, it is good practice to form the mould so that a number of feathers or thin ribs are cast, connecting the boss with the plate. These assist in reducing the strain caused by the unequal cooling of the metal owing to the abrupt change in the thickness. The preparation of the mould for these feathers requires considerable care, to prevent any likelihood of portions being separated by the inrush and pressure of the molten metal. In castings there is always a considerable degree of uncertainty, the conditions upon which their soundness depends being numerous, com-

Fig. 10.

Fig. 11.

prising subtle chemical and physical effects and internal stresses due to shrinkage when cooling. It is the moulder's duty, however, to take every precaution to fulfil the requirements as far as the mould is concerned.

After the mould has been thoroughly slicked, and during the process, the composition forming the facing must be constantly watered because it becomes dry very quickly. A mixture of fine dry composition is formed by mixing a little plumbago and water to a consistency resembling that of paint. This should be applied to the mould with a swab. Small dabbers or prods are made over the mould, especially along the bottom of the chain guide, to collect any impurities which may be carried along with the metal, and also to act as pockets for any air and gas which may be confined in parts of the mould, and for those gases, notably nitrogen, which, having been taken up by the metal when in a molten state, are liberated at the point of solidification. Connect the runner and risers with the mould, remove all corners formed by the contact, and both top and bottom can be dried. During the time occupied by the preparation of the mould, the cores required would be receiving attention. Fig. 10 shows a form of grid which is usually employed for the chain guide cores, it being simply a flat skeleton grid having a number of flat wrought iron pieces cast in the terminal end being thinned off and clear of wrought iron. Two staples are cast in as shown, and two grids are required similar to each other, except that one is right and the other left-handed. Another grid is required for the centre core. The

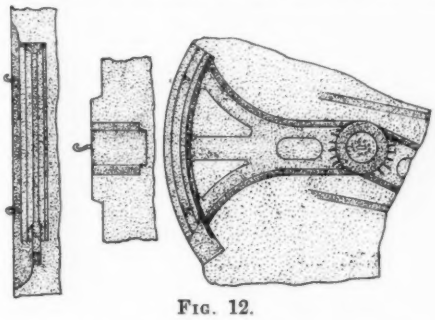

Fig. 12.

one shown in Fig. 11 is suitable if a corebox is supplied, but if a pinboard is used for the construction of the core the centre bars of the grid must be omitted, but a couple of lugs can be cast on to take two staples for convenience in lifting. The preparation of these cores is comparatively simple; they are best formed in loam composition, the two for the chain guide being vented to the outside of the corebox, shown in Fig. 10, care being taken to reverse the terminal end block after one core has been made before beginning the next one. The centre core need only have a thickness of about 3 in., the inside being left hollow, but precaution must be taken when closing the mould to secure a close contact between the top of thee orea nd the cope. The cores must be dried and the two for the chain guides given a coating similar to that used for the mould, but in the case of the centre core, coal tar would be preferable. Fig. 12 shows a part plan of the mould having two of the cores set in their correct relative positions, and the sections which show the joint of the mould through the centre and along the chain guide cores. The heads or basins should next be prepared, and it is just as necessary to use care and patience on these as on the mould. Too often their preparation is hurried, with consequent neglect in finishing details which may give trouble in casting. The pouring head should be large enough to supply the necessary pressure, and prevent the possibility of splashing the metal.

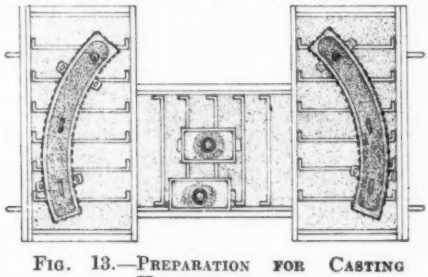

Fig. 13.—Preparation for Casting Horizontally.

Prepare them in strong composition either in suitable boxes, or on specially-formed plates having dabbers or prode cast on about the outside, so that a receptacle can be prepared inside. These should be dried and coated with tar. When the cores have been placed in position and vents drawn off, a small amount of chalk or whiting should be placed on the top of the centre core and the cope lowered into position. Drop some

chalk through the runner and flow gates, and lift to make sure that the contact is right. It may be necessary to place a little clay round the top of the centre core to seal it. To do this, cover it with oil or black fat, remedy any slight inaccuracy with the gates, and lower the top box into its final position. Surround the box part with a number of vents carried towards the cinder bed and prepare to cast. Fig. 13 illustrates the heads or basins set into position when the work is cast horizontally, and a method of casting is shown in Fig. 14, when two box parts are used. A spray is formed from the gates to supply the molten metal to the ends of the chain guides and plates, the flow gate being off the side of the boss and connected along the full length of it. In both cases they must be securely clamped or bolted before pouring the metal. Especial care is necessary in the latter instance, and it is advisable to lower it into a pit and ram sand about the sides. The method adopted depends upon the general practice of the individual foundry: if the former, then one ladle containing the requisite amount of metal will suffice; if the latter, then two ladles must be used for pouring at each end. It is, of course, necessary to calculate the amount of metal required and make a certain allowance for safety. When all precautions have been taken to prevent any springing of the top box, and the ladle of metal is lowered above the head, begin to pour, maintaining a steady stream of metal to provide an even pressure. When the flow gates are showing

Fig. 14.—Method of Casting with Use of Two Box Parts.

metal the heads can be filled up with the more lively metal from the ladle. If this is done expeditiously, it is possible to lift the head of metal in the main pouring basin. When the casting has become sufficiently cool for safe handling, it is removed to an annealing furnace, where it is packed up to maintain the correct shape. In work of this character it is very necessary that the annealing should receive great consideration, as the internal strains set up during the time of casting renders the casting liable to rupture, and as a rudder arm is of vital importance, every effort should be made to render such a rupture unlikely. Simply warming the casting is unavailing and useless. It should be gradually raised to a red heat and the temperature gradually reduced It should be remembered that more care is necessary in reducing the heat to eliminate as far as possible all traces of strain. After annealing, steel castings are usually tested either by the drop test, which simply means lifting the casting by a special sling so that it can be dropped upon the foundry floor, holes being dug out of the sand to prevent projecting parts being injured, or by the hammer test, which is actually sounding the casting for internal cavities.

CHINESE IRON FOUNDRY.—According to the Chinese Government Bureau of Economic Information, a joint-stock company has been formed in Chungking for the establishment of an iron foundry. The project is expected to cost about $2,000,000.

RECLAIMING DEFECTIVE CASTINGS IN MALLEABLE-IRON FOUNDRIES.—A recent issue of "Autogenous Welding" contains some interesting observations on welding malleable castings. Defective castings cost the malleable foundry more than the grey-iron foundry, and thus reclamation of malleable castings is very desirable. 1. Malleable foundries may reclaim castings in the white iron state by using white-iron filling-rod, provided the castings are carefully preheated and cooled to equalise the strain. 2. Malleable castings may be reclaimed by brazing using tobin bronze rod. The bronze produces a strong and effective repair but is objectionable to some customers because of the obvious repaired defect. 3. Castings may be repaired after the malleablising process using malleable iron or steel filler-rod, but only at the cost of reducing the strength of the casting.

Prevention of Explosions in Air Compressors.

Explosions in air-compressor mains have at various times been responsible for serious accidents on the Witwatersrand and in other mining fields. In an article, recently published in the "South African Mining and Engineering Journal," Mr. William Smith, of Kimberley, describes a device for the prevention of such accidents, or at least for reducing to a minimum the risk of an explosion in air-compressor pipes. At times there is an excessive temperature at the L.P. and H.P. outlets of an air compressor under working conditions, and, according to some authorities, in pipe lines and receivers. Mr. Smith introduces a fusible-plug chamber in proximity to the air-compressor discharge pipe. A pocket is cast in the chamber, and a fusible plug is screwed into the inner part of the pocket, so that the fusible plug projects into the bore of the pipe. A 2¼-in. gas plug seals the pocket, and may be easily removed to change the fusible plug when necessary. A pipe above the 2¼-in. gas plug forms the source where air is obtained to work the safety device, in the event of overheating of the compressor, as the alloy in the fusible plug melts and admits air into the pocket. Above this pipe a by-pass is fitted, controlled by a cock. By opening this cock, air is admitted into the system, and thus the device may be tested when desired.

To avoid the cost of the fusible-plug chamber, there is another method equally good, provided the air-discharge pipe is thick enough. In this alternative arrangement the plug projects into the bore of the air pipe, and the plug being hollow, a second plug fits in with ¼-in. holes near the end, to pass air to a ¼-in. outlet when the alloy in the first plug fuses. The second plug has a dead end for the alloy to strike against, and the outlet holes, being on the side of the plug, cannot be choked. The latter arrangement is probably quite suitable to most lay-outs of air-compressor pipes. Where desirable, fusible plugs may be placed at other points in the air line, in addition to the plug close to the compressor discharge, and coupled by pipes to the system operating the safety device.

A mixture of two tin and one lead would be suitable for ordinary fusible plugs, and of nine tin to one lead for operating automatic devices on two-stage compressors, and a pure tin for single-stage compressors.

A recent report on investigations of explosions in compressed-air systems states that it is preferable to have an automatic device installed on a compressor, in order to close it down when the temperature rises unduly, rather than to rely upon the man in charge, because the rate of rise in temperature may be so rapid as to forestall the human element.

The device suggested by Mr. Smith is automatic. When the alloy melts in the fusible-plug chamber, air is admitted to a cylinder containing a butterfly valve, and the valve closes, stopping the compressor. At the same time air is admitted also to the cylinder of a relief valve, opening this and evacuating the foul gases. The butterfly valve may be arranged to shut down more than one compressor by placing the valve in the main steam pipe.

In the case of the butterfly valve the air enters the cylinder at the bottom and closes the valve. A light wire lanyard may be attached to a shackle on the lever of the valve for opening the valve previous to starting up. Before opening the butterfly valve, it is advisable to note that sufficient steam has leaked past the valve to ensure an equal pressure on each side of the valve.

The internal part of the relief valve on the main air line outside the compressor room consists of a 5-in. piston with two rings, scarf joints, and a 4-in. mushroom valve. The valve and piston are fixed on a spindle; the pressure of the air main keeps the valve closed. On the bottom of the cylinder cover is a small jet cock, to relieve the system of air after testing the device. A ¼-in. diameter hole in the cylinder above the travel of the piston prevents a vacuum forming and allows the valve to close by gravity. The valve is placed in a dead end to keep it free from oil mixed with air in the main air line.

Sir A. McAusland Kennedy, president of the Shipbuilding Employers' Federation of Great Britain, has been admitted to the freedom of the City of London as a member of the Shipwrights' Company.

The Commerce Club, 316, Regent Street, W.1, has been especially organised to further the efforts of manufacturers and merchants who desire efficient facilities for coping with West-End trade. The premises contain a very extensive floor area and ample space is available for show cases and permanent exhibits of manufactured specialities.

Institution of British Foundrymen.

NEWCASTLE BRANCH.

At a meeting held in the Mining Institute, Newcastle, on February 26, a paper on "Mechanical Tests for Cast Iron," was read by Mr. F. J. Cook, Mr. R. O. Patterson, Branch Vice-President, in the chair.

"Mechanical Tests for Cast Iron."

This lecture has been given before the London Branch, and appeared in our issues of Feb. 10 and 17.

Discussion.

The Chairman said they were indebted to Mr. Cook for a very interesting paper. With regard to American *versus* English iron, there was no doubt the latter was much superior. When he finished his apprenticeship he worked for some time in the States making marine engines, and he remembered being able to cut off a bevel with his penknife. How that iron was going to stand the wear and tear of engines he never could understand.

MR. H. J. YOUNG, F.I.C. (Wallsend-on Tyne), said that while he much appreciated this lecture as coming from a foundryman, at the same time he did not agree with a great deal of its metallurgy. He thought, partly from what he heard that evening and partly from what he had read elsewhere, that Mr. Cook's metallurgical ideas had not been seriously criticised by such metallurgists as existed, whose daily experience was mainly that of cast-iron foundrywork. This he now desired to do, but particularly did he wish to point out that he highly appreciated Mr. Cook's work, and this criticism was in no way antagonistic or destructive.

In the first place Mr. Cook laid down a law that "The whole physical properties of cast iron depend upon the quality and condition of the carbon, the value of the other elements being in accordance with the effect they have on the carbon and the condition in which it exists." He (Mr. Young) pointed out that this law really meant that all cast iron varies only as its carbon varies, or conversely, that there can be no variation without a variation of carbon. In the light of present day knowledge this would appear to be not only incorrect, but also very misleading to foundrymen.

There are many different series of cast irons, just as there were in the case of steels, and although we have not yet reached that state of knowledge when the full facts of even any one series are publicly known, we are nevertheless well aware of their existence. Mr. Cook himself, knowingly or unknowingly, mentioned two of those series when he pointed out that iron of low sulphur content did not possess as good wearing properties as an iron with 0.12 per cent. of sulphur, this apart altogether from its carbon.

Indeed, altogether Mr. Cook mentioned four or more other series, some of which he called "freaks," but in reality they were by no means "freaks," and Mr. Cook might ponder over the fact that one at least of these so-called "freaks" was explained, so he said, by his formula, which is unlikely if it were really a freak iron.

This formula was:—

$$S\,C = \frac{C}{Sil}$$

$$4.26 = 3.6$$

and he (Mr. Young) thought it was altogether too empirical, namely, applied without science.

Its very terms were extraordinary, as, for instance, the fact that whereas all ironmasters and most foundry people and all metallurgists called silicon by the term "Si" and sulphur by the term "S," Mr. Cook called silicon "S" on one side of his equation and "Sil" on the other—surely an unfortunate and unnecessary coinage of symbols, which could, if allowed to expand, lead to a ludicrously tangled state of affairs. Further, and what was more important, he (Mr. Young) thought he could show that the formula was quite redundant, and that foundrymen would be better told in plain terms what were Mr. Cook's ideas as to the amounts of silicon that should be present with certain amounts of carbon, or *vice versâ*, rather than be given a formula which most of them would be unable to apply. For instance, when he (Mr. Young) wished to know Mr. Cook's opinions he will refer to the following table:—

With Silicon present:—	Per cent. 0.1	Per cent. 0.5	Per cent. 1.0	Per cent. 1.5	Per cent. 2.0	Per cent. 2.5
Loco. cylinders, C. should be:	3.5	3.4	3.3	3.2	3.1	3.0
Diesel cylinders, C. should be:	3.2–3.5	3.1–3.4	3.0–3.3	2.9–3.2	2.8–3.0	2.7–2.9
Ordinary work, C. should be:	3.8–4.2	3.7–4.1	3.6–4.0	3.5–3.8	3.3–3.7	3.2 3.6

This would seem to be a perfectly clear and simple exposition of Mr. Cook's ideas, and do away with the many doubtful points involved in his formula and also with all necessity for calculation whenever one wished to refer to any particular percentage of silicon or of carbon. In order to work the formula one has to know the amount either of silicon or of carbon, and the above table gives instant reference to either.

Another point in Mr. Cook's discourse was his reiterated statement that the drill test for hardness also showed the density. Now, everyone in works knows what he means by hardness in any particular case, and the drill-test was very excellent, as also was the Brinell, Scleroscope, etc., each with its own individual purpose and meaning.

As regards density, however, he (Mr. Young) entirely disagreed with Mr. Cook, and he did not think that the drill-test would show the comparative density of two cast irons any more than it would show it when applied to pure gunmetal and to leaded gunmetals. It is likely that Mr. Cook does not mean density, but closeness of grain; but once again the drill-tests will not show the closeness of the metal when it is applied to cast irons of certain series. Curiously enough, Mr. Cook has applied it to some such irons, and they did not give comparative results, and Mr. Cook promptly labels the irons as "freaks." It should be mentioned that these particular irons do not appear in Mr. Cook's written paper, although he showed their results on the screen.

This application of the word "freak" to everything outside of one's experience is a very unsafe procedure, and likely to limit progress, and in cast iron particularly should we closely examine all such freaks in order to discover whether they are not members of perfectly normal series. Much of the tradition woven around the products of Scotch and of cold-blast irons are probably founded upon this train of thought, which leads to the name of freak being too frequently and too freely applied. He (Mr. Young) has met with many peculiar cast irons possessing many peculiar properties, but they are clearly cases where knowledge is as yet insufficient, and tests are as yet non-existent to show us the reason why these irons are different to others within our knowledge; but to hold them out as "freaks" is stating something which one cannot prove by facts or by experience, and is giving a false lead to younger workers.

He did not agree in any way with Mr. Cook's explanation of the "break" on molten iron; and while the theory on the subject was too deep to discuss there, he would like to point out to Mr. Cook that hot water when cooling possessed movement, and probably had a "break" could we but see it, but in that case there was no manganese and no oxidation. Non-ferrous metals, as everyone know, showed very wonderful surface effects, and the subject was, in Mr. Young's opinion, a much deeper one than in any way suggested by Mr. Cook.

Regarding test-bars, this Institution could not do better than follow Mr. Cook's lead and put forward some bars of standard size cast in moulds of standard dimensions and made of standard materials, and the metal cast under standard conditions from the ladle.

Everyone knew that test-bars cast on castings did not represent the castings, and never could do so. Even test-bars cut out of castings represented only the parts of the casting from which they were cut.

As regards the origin of test-bars being placed on castings, he (Mr. Young) thought that it might possibly have come from the fact that, at one

time, foundrymen were given to "faking" test-bars cast from hand-ladles, and the inspectors might have thought that to attach them to the castings would do away with any possibility of such procedure.

Meanwhile, any progressive foundryman could use the American standard bar, and would gain much knowledge by using it every day, without any reference to inspectors or specifications, for pure pursuit of information.

Mr. Robert Wallis agreed they were greatly indebted to Mr. Cook for several points in his Paper. Speaking from the engineering point of view, he thought most of them could tell a lot of stories about how tests were got, especially when the test-bars were cast on the casting. A great deal depended upon how they treated them and how fast they were cooled. The attempt to give a standard specification, and to secure definite and stringent conditions under which the test-pieces were made was a step in the right direction, and one which would go a long way towards giving them uniform results from the foundry, because if they had a standard method of making the test-bars then they would have some uniformity in the results; and if the results were not then uniform, it was necessary to find out why they were not. That would tend to make foundry work more of an exacting operation than just the haphazard method now existing.

Mr. Cook, replying to the discussion, said Mr. Young had taken exception to the formula, and said that no foundryman could work it because it was so difficult. As a matter of fact, he could assure Mr. Young that he knew a great many foundrymen who were using it and securing excellent results from it. He agreed with Mr. Wallis that the standardisation of bars was desirable, and that the rate of cooling had a great effect upon the conditions.

LANCASHIRE BRANCH.

Discussion on Mr. J. Pell's paper on Some Experiences of Cupola Practice.*

The Chairman (Mr. Meadowcroft) said he had heard practical men say that some of the Papers read before the Branch were too technical and too far removed from every-day working conditions for them to understand. That could not be said of Mr. Pell's paper because it had reference to difficulties which every one of them was up against at times.

Mr. J. Hogg said he would like someone to take up the question of the height of the bottom tuyere. He had previously seen the cupola which had been described, and he advised Mr. Pell to raise the bottom tuyere 6 in. with a view to raising it further later. The first time he saw it it was almost ridiculously low. The diameter of the tuyeres was then about 3 in., and he advised that it be increased to 3½ with a view to increasing it by degrees to 5 in.

Mr. Faulkner said if the present conditions were maintained he was going to try to prove that it was possible now with the electric furnace to produce castings quite as cheaply as they could be produced with the cupola, although the cupola was supposed to be a very cheap method. The case had been proved in the United States and he wanted to gather a little more information before trying to make out the case for Great Britain. He wanted to know: (1) What will be the average cost, using no material other than the cheapest meltable scrap on the market; (2) what will be the average cost of such material? If there was a serious difference in the cost of a normal cupola charge and one such as has been described, there was room for a duplex system in the British foundry, as they would be able to get the metal very hot, and fluid. They would have to make the sand more refractory. An outstanding advantage of the duplex system was, of course, in connection with sulphur. Sulphur was automatically reduced in the electric furnace. Sulphur existed in liquid steel or iron as a sulphide, and as it had a lower specific gravity than the steel or iron, it naturally rose to the surface, especially if superheated to a high temperature. It was then absorbed by a lime slag, with the result that it was quite a simple proposition to run the sulphur down from 0.1 to 0.05 per cent., and, if necessary, it could be lowered to 0.005 per cent. The foundryman was up against this sulphur problem, because every time the scrap was remelted it was taking up a little more sulphur, and as scrap had been put through a cupola time after time, the proposition became very serious. With the electric furnace they would be able to use cast-iron borings—the cheapest stuff they could get hold of—and still turn out material superior to normal cupola metal.

In considering the results given by Mr. Pell, they must not overlook the enormous modification that would result if no heat units were used up in melting the cupola lining. The author had referred to the mixing of pig-iron and scrap. He thought it paid. He would certainly advocate using a big ladle, so that they could be sure that they had got the several mixings together.

Mr. A. L. Key said the basic principle of cupola practice was the relationship of pressure to tuyere area. They know how in a compressed-air pipe the force varied with the size of the opening through which the air passed. The same applied to the cupola. In this case, if he might pass a comment upon the construction of the cupola, he would say it was quite out of proportion. The tuyere ratio was approximately 20 to 1. His experience of a good ratio in that particular size of cupola was 7 to 1. The arrangement of the tuyeres, one above the other, was also bad. In his opinion, Mr. Pell's theory was quite right with regard to the air blowing horizontally across the cupola.

He did not attach so much importance to the fluxing of the bricks as to the quality. The quality was not good—that was indisputable—but at the same time if one had good quality bricks in that cupola he thought they would burn away all the time, because the air pressure was too high. He understood Mr. Pell to say he had 15 oz. on a mercury gauge. That was really about 30 to 40 per cent. more than it should have. One must have a high-pressure against a small tuyere area to get sufficient air into the cupola. If they had a small opening they had to have a higher pressure in order to pass sufficient air through those small openings to get combustion. If the orifices were sufficiently large, they could have the same quantity of air passing through without having the same pressure.

Their own cupolas were similar in dimensions, and they melted 6 or 7 tons an hour with a blast-pressure of 18. in. of water, or approximately 11 oz. They only used 11 oz. when the lining was worn; when the cupola was re-lined, they used 10 oz.

He could give a little experience of his own as showing the effect of blast-pressure. A foundry was getting very bad results with small castings. Analysis had shown that the material was of good standard quality, so the cupola practice was examined. He had previously calculated the tuyere area, and he came to the conclusion that the wind was excessively high, and also found that they were using 50 per cent. more coke than was requisite. The reason was established to be that in the early stage when the trouble commenced they thought the iron was not sufficiently good, and they put more wind on. The iron got a bit hotter, but soon lost its heat, and, to effect a further improvement, they put on more coke. Again thinking that the conditions were not quite right, they put on some more blast; and at the end they had 40 per cent. more blast than there should have been normally, and they were burning 50 per cent. more coke. After that was discovered the blast was dropped 40 per cent. and the coke was dropped 50 per cent., the same material was used, and the trouble disappeared. In his opinion, that was a conclusive proof that the whole question centred round the working conditions of the cupola, or, in other words, the relationship of the amount of blast to the size of the tuyeres. Other conditions to be considered are the facilities for air entering the cupola. The cupola could be worked at 18 oz. if desired, providing the tuyeres would allow of that pressure being used effectively.

With regard to the first melting, that depended upon several factors—the material, the quality of the coke, the conditions of lighting; the metal

* For Paper, see page 207 *et seq* in the March 31 issue of "The Foundry Trade Journal."

would be affected considerably by the state of the bed that it dropped upon. Of course, the first melting would be more highly impregnated with sulphur than the rest of the metal, for the simple reason that the bed charge was lying, say, 2 ft. above the tuyere, and they also had 2 ft. 6 in. below, so that there was 4 ft. 6 in. of coke in a highly incandescent state. Consequently, the first iron would get the bulk of the sulphur. Afterwards the sulphur was more or less minimised.

He did not agree with Mr. Pell that the colour of the slag was of no practical importance. Suppose a foundryman, having laid down regulations for the cupola, happened to be away one afternoon, and it was left in the hands of a man who wanted to experiment. The following morning the slag would probably be different, as, within reasonable limits, one could determine from the colour of the slag the working conditions of the cupola. There was a great difference between a black, dull, heavy slag and a very light slag. There they got two extremes of working. From the practical man's point of view, slag analysis was really a secondary consideration.

Mr. H. Sherburn quite agreed with Mr. Pell that it was time some standard were established with regard to cupola design. On all new furnaces there were certain factors which could be broadly defined, and all these factors could be embodied in a specification. The difficulty was that most foundrymen had to deal with furnaces which were already in existence; for them it was more a question of making the best of things as they now obtained than considering what should be done in a new situation. Take, for instance, the position of the tuyeres. That was a matter that could be settled definitely. If the furnace had to hold a certain amount of molten metal, obviously the tuyeres must be placed higher than they would be if the amount were smaller. If they did not want to hold metal in the furnace, to have the tuyeres high up would be throwing coke away every time on the beds.

With regard to the double row of tuyeres, personally he was opposed to the arrangement. In the furnaces he was now using the design provided for two rows of tuyeres, but the upper ones had been blocked, and all the tuyeres were now on the lower level. By that means they were able to save coke on the bed. When such points as these and in regard to the relation of tuyeres and furnace to melting ratio, it was high time that a standard was prepared. The Institution was a competent authority to carry it through.

He did not approve of the use of a brick of the type described by Mr. Pell: obviously, a brick so large as that was very difficult to burn throughout. He would suggest that a narrower brick be used, or by taking a smaller section—by having the brick cut into three, vertically—they would be sure to get the brick free from a half-baked core.

Some authorities told them they should always put the pig-iron in first and the scrap behind it. In general, he believed they were right. Obviously, scrap would melt more easily than pig, and by putting the scrap behind the pig there was a better chance of securing uniformity than if they were mixed together.

With regard to slags, from his own observation, he did not take too much account of the colour of the slag. The best method was to work the slag with as high lime as possible without cutting the lining, and work in that manner the whole of the time. By so doing not only is clean metal obtained but they would prevent the metal going into the slag. It was remarkable how much iron could be lost in that way by founders who did not occasionally analyse their slag. There are several elements in cast iron which had a colouring effect, and in relying upon colour in a slag as a test of its quality was not reliable. A furnace should have not only a pressure gauge, but also a volume gauge, and both should preferably give an automatic record.

The Chairman (Mr. W. H. Meadowcroft) said he had given a great deal of consideration to this question in past years, and had experience of quite a number of furnaces, and the position he was reduced to was this: a furnace with a simple straight stack, suitable tuyeres and sufficient area to get the right amount of blast was about the best. A careful furnace man who would see that the furnace was looked to in good time would get fairly good average results. Still, great economies could be brought about in the cupola. One of its weak points was that it was generally worked with a very short stack above the charging door. The charging itself was a great drawback in the present-day form of the cupola. A recent experience of his might be of interest to the members. There was a certain cupola standing derelict owing to the very heavy steam consumption. The annular tuyere was closed up. Two 6-in. dia. tuyeres were fixed 20 in. from the sand bottom. They were connected to a small motor-driven fan. The cupola was 2 ft. dia. inside the lining. The charging bell and stack were left intact, which gave a continuous stack 40 ft. high from the tuyeres. As no cold air was admitted above the fire a tremendous pull was obtained from the stack, which lowered the amount of power required to drive the fan. Two and a half hours from lighting the fire molten metal could be seen dropping past the tuyeres before the blast was started. With a 5-h.p. motor 3 to 4 tons of really hot metal was melted per hour.

To his mind, the long stack was a thing that could be developed, and a furnace made on those lines would not be any dearer than the ordinary furnace, because the stack above the charge would be considerably less in diameter. In that way an improvement could be made in the cupola.

Mr. Pell said, in reply, in August, 1914, expert advice was given upon this cupola, which, summarised, read: "There were four tuyeres only 3 in. in diameter, and the diameter of the cupola inside was 35 in. The total tuyere area should be 240, the cupola area 962, taking a ratio of 4 to 1; but, in fact, the tuyere area equalled 28,272 ins. the ratio therefore being about 34 to 1. That showed the enormous pressure with which the air must be entering the cupola. The blower should deliver 3,800 cub. ft. of air per minute. To melt 5 tons per hour would require 150,000 cub. ft. of air, and the 3,800, multiplied by 60, equalled 228,000 cub. ft., or 1½ times the amount required. It was therefore quite plain that both the quantity and pressure were in excess of the best practice, and this necessitated a larger consumption of coke both in beds and in charges. A great oxidation was taking place, which had the double effect of hardening the iron and wasting a considerable amount of it. It would not be surprising if the yield of iron was at least 10 per cent. lower than what was being put in, and the excess of coke had other deleterious effects on the castings."

Mr. Sherburn had referred to putting pig-iron on first and scrap afterwards. As he mentioned in the Paper, they used 50 per cent. pig-iron and 50 per cent. scrap. If, with a charge of 1,500 lbs., they put 750 of pig-iron first and 750 lbs. of scrap afterwards, he believed they would be getting pig-iron on one tapping and scrap on another.

A vote of thanks was then accorded Mr. Pell.

Core Sands.

In the current issue of "La Founderie Moderne" the following composition is recommended for small and medium-sized cores:—Silver sand, 220 lbs.; boiled linseed oil, 1.6 pints; powdered resin, 4.4 lbs.; and dextrine, 10½ oz. For larger cores add more dextrine, which will have the effect of hardening them. The oil should be heated in a fairly tall vessel together with the resin, care being taken to continuously stir the mixture until boiling is reached, when the receptacle should be withdrawn from the fire and the contents poured over the sand, adding thereto the necessary water, which will average about 1¾ pints, to produce the necessary consistency.

This mixture should be well worked up by hand and in the mill.

This sand is satisfactory for plate moulding, as it requires very little reinforcing, only a bar or two of iron or a few moulders' sprigs, and an air vent in each portion, being necessary.

Cores made of this material give good results, and should be dried at low temperature, say 300 to 350 deg. C. Castings made when using such cores are easy to clean.

Trade Talk.

SUBSTANTIAL reductions are reported in the prices of products of the U.S.A. Steel Corporation and its subsidiaries.

ALL departments of the Birtley Iron Company's works in Durham County except the foundries have been closed down owing to the coal stoppage.

THE Government make an earnest request to employers to keep open the places of the reservists of the Navy, Army, and Air Force who have been called up in the present emergency.

THE meeting of the Association of British Chambers of Commerce, and the annual dinner, which were to have taken place at the Hotel Cecil on Tuesday last, have been indefinitely postponed.

OWING to the slump in the world's metal prices, and the general economic position, the Australian Federal Government is reported to have decided to permit the exportation of ores from Australia.

ACCORDING to latest reports from Japan there seems no doubt that the Bill for the abolition of import duties levied on shipbuilding materials in the interest of the shipbuilding industry will be passed.

WITH the launching of the steamer "Ravenfjell" at the Forth Shipbuilding Company's yard, at Hebburn, immediate building operations have ceased, and a large number of workmen have been discharged.

ACCORDING to the latest figures from the Unemployment Exchanges in the United Kingdom, there were on the registers at April 1 (preliminary figures) 1,505,700 persons, compared with 1,413,751 on March 24.

ACCORDING to Mr. Frank Forrest, M.I.E.E., chairman of the Institution of Electrical Engineers, in an address at the Birmingham and District Electric Club, plans for the Midland electrical power scheme are well advanced.

IT is reported that the United States Steel Corporation will shortly announce a price and wage policy, following a meeting of presidents of the Corporation's subsidiary companies and the sales managers, with Mr Gary, the general president.

A MEETING of the Sheffield Society of Engineers and Metallurgists was held in the Mappin Hall, Sheffield, on Monday, when a lecture was given by Mr. W. J Rees, F.I.C., of Sheffield University, on "Refractory Materials for Furnaces and Construction Purposes."

MR. F. J. ROBBINS (Cardiff) presided at the annual meeting of the West of England and South Wales Iron, Metal, and Waste Trades' Association, at Bristol, when Mr. Harry Baker (Messrs. Thomas Jones & Company, Cardiff) was chosen as president for the ensuing year.

As the result of the quarterly ascertainment, blast-furnacemen on the North-East Coast suffer a substantial reduction in wages as from April 3. The reduction amounts to 26.25 per cent., which will bring the men's wages from 170.25 per cent. above the standard to 114 per cent. above the standard.

THE first metal ship launched from the shipbuilding yard of Messrs. R. B. Harrison & Sons, Limited, Bill Quay-on-Tyne, took place last week, when a finely-modelled steel screw coasting steamer, one of two being built by the firm to the order of Mr. Thomas Rose, of Sunderland, was placed in the water.

LAST year was an exceptionally busy one in the registration of limited liability companies, the total number so registered being 11,011, or 286 more than in 1919; 3,586 more than in 1913, the last pre-war year. Under the classification "coal, iron, and steel" there were 425 registrations, compared with 255 in 1919.

THE civil engineering and contracting department of Sir W. G. Armstrong, Whitworth & Company, Limited, has been successful in obtaining in competition the contract from the Crown Agents for the Colonies for the Ebute Metta workshops, which are to be erected near Lagos for the Nigerian Government Railways.

THE Lyons Fair, which opened last month, was attended by officials representing the British Government, and the delegates were impressed with the interest taken in the event, and the support accorded to it by all classes of the community, who appreciated its importance as a national and municipal institution.

THE Iron and Steel Trades Confederation compute figures submitted from 103 of its branches that at the end of last week, without taking into account the effect of a strike by the railwaymen and transport workers, should that happen, there will be no fewer than 97,000 members of the Confederation unemployed.

THE salaried staff of the American Smelting & Refining Company are to receive a 20 per cent. reduction in pay from June 1, whilst the wage-earning classes are to be cut down from 30 per cent. to 40 per cent. These reductions in pay are to be applicable to every employé of the company, from the president downwards.

THE unions represented at the recent conference at York between engineering employers and the men's representatives on the subject of women's wages in the industry declined to accept the new rates proposed by employers involving reductions of existing standards, and adjourned to report on the position to their Executives and members.

A JOINT committee of employers and employed in the cast hollow-ware trade met in Birmingham last week to continue the adjourned discussions relating to wage reductions. It has been stated that the proposals will mean a reduction of approximately 18s. a week in the case of piece-workers, and 9s. a week in the case of day workers.

THE output of the Tayeh iron mines in China in 1919 was 762,804 tons, the bulk of the exports being taken by the Japanese, who control a percentage of the production. The remainder was consumed by the Han yang Iron and Steel Works, which turned out 186,071 tons of pig-iron, 4,850 tons of steel ingots, and 3,950 tons of other steel products.

ENGINEERING and shipbuilding employers are no longer obliged to give their workers seven days' notice of the termination of their employment, or, alternatively, a week's pay in lieu of notice. An order just issued under the Ministries of Munitions and Shipping (Cessation) Act places them at liberty to revert to pre war practice in the matter.

THE ENGINEERING EMPLOYERS' FEDERATION announce that it is their intention to introduce a general reduction in the wages paid by federated firms of 6s. weekly for time workers and 15 per cent. for piece-workers, together with 12½ per cent. on the earnings of time workers, and 7½ per cent. on those of workers under systems of payment by results.

A BALLOT is being taken amongst the members of the Amalgamated Engineering Union on the proposal to increase the levy to 1s. 6d. for the payment of extra benefit to unemployed members. This is in accordance with the recommendation of the National Conference. The executive strongly appeal for a favourable vote, which is returnable on April 27.

A NEW pumping engine has been erected at the Pode Hole Pumping Station, near Spalding, by the Deeping Fen Drainage Trustees. It is a Diesel oil engine, with a pumping power of 110 to 120 tons a minute, and is similar to one installed seven years ago. The engines at Pode Hole Pumping Station are now capable of raising 800 tons of water a minute.

UPON Counsel's application, Mr. Justice Lawrence in the Chancery Division has fixed April 20 for the hearing of the actions by Frank Thompson, of Penarth, David Dill, of Swansea, and Robert William Cousins, of Mumbles, against Henry Bath & Sons and Morrison Kekewich & Company, relating to spelter transactions on the London Metal Exchange.

THE Dominion Steel and Nova Scotia Steel companies have approved of the agreement to unite the two companies and the Halifax Shipyards as the British Empire Steel Corporation. Holders of the common shares will exchange all their shares in the old companies for cumulative 7 per cent. second preferred and common shares in the British Empire Corporation.

ACCORDING to the Board of Trade returns for March, the quantity of iron and steel and manufactures thereof exported last month was 148,852 tons, compared with 290,039 tons in March, 1920, while the value was £6,492,439, against £9,442,117. For the three months the quantity was 548,101 tons, against 773,584 tons, and the value £24,406,567, against £24,541,074.

IT was reported at the meeting of the Tees Conservancy Commissioners at Middlesbrough that the imports to the Tees of billets, blooms, and slabs from Holland, Belgium, and France last month totalled 1,380 tons, as compared with 5,661 for the corresponding period in 1914. Imports of plates, bars, angles, rails, sheets, etc., last month were 2,707 tons, against 3,336 in March, 1914, and pig-iron imported last month was 11,722 tons, compared with 54 tons in March, 1914.

WHEN the directors of Sheffield Steel Products, Limited, offered a number of ordinary shares to their employés a great many availed themselves of the opportunity of making small investments in the business which was paying their wages. It is now announced that, in addition to the payment of a dividend of 10 per cent. for the year, employé shareholders are to receive a bonus of a shilling per fully-paid share, tax free, and ninepence per share on all shares on which the instalments have been regularly paid.

THE second meeting in connection with the formation of the Institution of Production Engineers was held in London on April 2, when Mr. Cecil F. Hammond, of Coventry, presided over a large attendance. The Chairman referred to the way in which the Provisional Council came into being, and added that they had found it necessary to constitute themselves into an incorporated Institution, and under the proposed Articles it would be seen that the Council had power to add further members up to twenty-six. The following gentlemen were elected to the Provisional Council:—Mr. Wallace Attwood, Mr. G. H. Hales, Mr. Max R. Lawrence, and Mr. J. B. Robson.

Company News.

Dominion Steel Corporation.—Dividend at the rate of 1½ per cent. on preference.

M.E.C. Electrical Company, Limited. — Capital £1,000 in £1 shares. Registered office: 9, Stoney Lane, Birmingham.

R. and J. Evans and Company, Limited, shipbuilders, —Capital £20,000 in £1 shares. Registered office: 45, Caryl Street, Liverpool.

Geo. Stephenson & Sons, Limited.—Capital £20,000 in £1 shares. To acquire the business carried on at Newark-upon-Trent, Notts., as "Geo. Stephenson & Sons," and to carry on the business of founders, engineers, etc. Registered office: Trent Bridge Works, Newark-on-Trent, Notts.

Bede Metal & Chemical Company, Limited.—Operations for 1920, after allowing for general management expenses and tax, have resulted in a loss of £2,949; deduct balance of profit brought forward after payment of directors' fees for 1919 £1,504, leaving at debit of profit and loss account £1,445.

Furness, Withy & Company, Limited.—Dividend on the ordinary shares at the rate of 5 per cent. per annum for the half-year ending April 30, 1921, being 6d. per share, free of income-tax, the usual dividend on the preference at the rate of 5 per cent. per annum for the half-year, being 5s. per share, less income-tax.

Metropolitan-Vickers Electrical Company, Limited.—The net profits for 1921 were £308,490, after providing for debentures interest, and £51,089 was brought forward. A dividend of 12½ per cent. is proposed on the ordinary shares, writing £35,000 off plant, adding £100,000 to the reserve and carying forward £58,824.

Nautical Engineering (Southampton), Limited. — Capital £20,000 in £1 shares (500 "A," 10,000 "B," and 9,500 "C"), to adopt agreements with the Safety Porthole Company, Limited, and F. Smith & Son (Southampton), Limited. Directors: R. F. Ball (chairman), J. H. Clarke, and J. C. Smith. Registered office: 23, Oxford Street, Southampton.

H. A. Watson & Company, Limited.—Capital £150,000 in £1 shares (50,000 7 per cent. cumulative preference). To take over the business of mineral and metal brokers, etc., carried on at Liverpool, and elsewhere, as H. A. Watson & Company. The first directors are:—C. N. Watson, W. W. Meyers, G. A. Williams, and L. G. Beaumont. Registered office: K., 30, Exchange Buildings, Liverpool.

John Summers & Son, Limited.—Balance, £206,590. During the year the company acquired share capital in the Buckley Colliery Company, Limited, and the Talk-o'-th'-Hill Colliery Company, Limited, and practically all shares in the Shelton Iron, Steel & Coal Company, Limited, and allied concerns. The Hon. E. B. Butler-Henderson and Mr. W. Simons, of the Shelton Company, have joined the board.

Death.

Mr. George Bell Proud, who died in New Zealand, on December 24, 1920, in his 82nd year, was formerly proprietor of the Albert Hill Ironworks, and was the first of the pioneer ironmoulders in that Colony.

Gazette.

Messrs. Wm. Thomas and Jno. Thomas, trading as the Bromley Hall Metal Crafts Company, Bromley, Pensnett, metal workers, have dissolved partnership. Debts by Mr. W. Thomas.

The Rodley Engineering Company, Limited.—It has been resolved that the company be wound up voluntarily. Mr. W. Walker, Butt's Court, Leeds, C.A., has been appointed liquidator.

The Composite Tool Company, Limited. — It has been resolved that the company be wound up voluntarily. Mr. L. M. Wyllie, 831, Salisbury House, London Wall, E.C., has been appointed liquidator. Meeting of creditors at liquidator's, April 19, at 12 Claims to liquidator by May 10.

The partnership heretofore subsisting between Messrs. Fred. Peel, Joseph Emmott, and Jas. Booth, trading as Peel, Emmott & Booth, Thornton Street, Collyhurst, Manchester, ironfounders, has been dissolved. Debts by F. Peel and J. Emmott, who continue the business as Peel, Emmott & Company.

Messrs. Alf. Towle, Wm. Geo. Francis, Herbert Mote, and Isaac Clarke, trading under the style of the Vulcan Pattern Making Company, Carlton Works, Much Park Street, Coventry, pattern makers, have dissolved partnership. Debts by A. Towle, W. G. Francis, and H. Mote, who continue the business.

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IRON AND STEEL MARKETS.

Pig-Iron.

Though modified to some extent by the more favourable turn of events in the labour position at the week-end, conditions in the pig-iron trade still remain compulsorily idle, and market movements are now confined within the narrowest possible compass. As illustrating the almost complete collapse of production, it may be noted that normally there are about 300 blast furnaces in operation in Great Britain, which speedily dwindled to 30, and last week-end there were probably no more than half-a-dozen. Such is the effect of the coal strike upon the iron trade. In Scotland most of the furnaces are already out or are about to be blown out. A good many makers hold iron stocks, and orders are filled from these. Quotations are nominal. At last week's Middlesbrough's iron markets, though a few orders were placed, the volume of business done was insignificant in quantity, and was met from makers' accumulated stocks, but as the weeks pass and fuel stocks dwindle, work at the foundries is also ceasing, and consumption of pig-iron is consequently on a rapidly diminishing scale. Chief anxiety now centres in the trade possibilities when the miners' strike shall have been brought to a conclusion. The recent cut in prices is certainly a step in the right direction, but even yet finality has not been reached in the downward movement, drastic though the reductions have been. Meanwhile foreign competition continues active, Belgian iron being on offer, delivered Tees, at £5 10s. per ton, c.i.f., and though local consumers may still show a preference for Cleveland qualities on the recently modified terms, it is feared Scottish trade may be diverted owing to the enhanced costs of transport to the northern ports. This movement, if continued, may have serious effects upon the Scottish outlet for Cleveland pig, hitherto the chief avenue for the disposal of Tees-side iron, and postpone indefinitely any prospect of the restarting of the furnaces on the North-East Coast on an extensive scale, even if the coal strike be promptly settled. Meanwhile it is suggested that as makers are now quoting for export f.o.b. at the same figure as for home consumption f.o.r., they might well forego the 2s. 6d. per ton charge which is made for putting iron for Scotland f.o.b. With this slight differentiation the uniform prices of Cleveland pig-iron are as follows: No. 1, 125s.; No. 3 Cleveland G.M.B., 120s.; No. 4 foundry, 119s.; No. 4 forge and mottled, 117s. 6d.; and white, 115s. per ton. Since the beginning of the month there have been no pig-iron shipments recorded, and the present position is absolutely unprecedented in the history of the trade.

East Coast hematite is reported as being sold for export as low as 160s., and as the fixed home price of mixed numbers is still 180s., there seems to be justification for the view that here also there will have to be an early reduction in prices. In West Cumberland and North Lancashire the hematite industry is at a complete standstill, smelting having practically ceased throughout the district. Prices, however, remain as previously reported, £9 per ton being quoted for West Coast mixed numbers.

Scrap.

In common with all other forms of raw material, the market for scrap is completely disorganised by the recent turn in events, sellers of even the best qualities of this class of material finding it difficult, if not actually impossible, to induce buying offers, no matter how favourable the terms quoted. Prices consequently are practically nominal, as instanced in the following quotations submitted in the South Wales area:—Heavy steel scrap in furnace sizes, £3 5s. to £3 10s.; bundled steel scrap and shearings, 70s. to 80s.; steel turnings, 50s. to 60s.; mixed wrought iron and steel, 30s. to 75s.; good machinery scrap, £6 5s.

Steel.

The outlook for the steel trade continues in an unsatisfactory position, and practically buying has been in negligible 'volume since the commencement of the miners' strike. This movement, though happily relieved by the last moment defection of the railway and transport workers from the Triple Alliance, is apparently no nearer an immediate solution than before, and production, so far as finished and semi-steel is concerned, is altogether idle, owing to the uncertainty of future fuel supplies. A few branches of the trade have, however, sufficient stocks of coal to continue working for a short time longer, the manufacture of railway material continuing to a limited extent, while some of the rolling mills and forges have still specifications in hand sufficient to maintain production for a short time longer. As indicating the decline of Sheffield industries last quarter, may be noted the substantial decrease in exports shown in the Board of Trade returns for March, the total tonnage of iron and steel and manufactures thereof, excluding ore and including scrap, amounting to 149,847, compared with 295,716 for the corresponding period last year. In the meantime, British consumers are buying more of these products from abroad, the total in March was 179,610 tons, compared with 72,491 tons a year ago, and 186,811 in 1913. Belgium sent more iron and steel than all the other countries in the list, chiefly billets, plates, and sheets, and bar iron. There was also a heavy importation of foundry and basic iron, presumably from Luxembourg and France. Germany sent very little. One item in the statistics is 3,000 tons of tram rails at £25 per ton, c.i.f. Depression has also overtaken the agricultural machinery trade, the present season being the worst experienced in the records of the industry. The entire cessation of demand for these appliances in the Eastern European markets will probably account for the slump to some extent, but similar conditions applying in the case of South American buyers have also largely affected the staple industry of Lincoln. The foundry trade is now only moderately active, and with the imminent prospect of an early entire stoppage of fuel supplies, is also subject to the disturbing influence of the labour upheaval in the mining industry.

Steel rails and fishplates have been reduced £3 per ton.

Finished Iron.

With all branches of the finished iron trade practically idle, last week's quarterly meeting at Birmingham attracted only a meagre attendance as compared with the usual gatherings on these occasions, travelling restrictions, owing to the strike, doubtless preventing many members from undertaking the journey, while the possibilities of doing business were not by any means encouraging in the existing circumstances. Retrospectively, the first quarter of the year has been the least satisfactory within the memory of many of the oldest members of the trade, the volume of business passing having been insignificant in extent, most manufacturers working on hand-to-mouth lines, with prices continually on the down-grade. The difficulties of the position of finished iron in the period just completed have been greatly accentuated also by the rapid growth of foreign competition, both in our home and export markets, some of the Belgian prices now quoted being far below the figures ruling for British products, and only to be counteracted by further drastic reductions in manufacturing costs.

As indicating the extensive developments in outside competition, the Board of Trade returns for March, just issued, show the following tonnage of iron bars, rods, angles, shapes, and sections brought in from abroad, chiefly from Belgium. In January the total was 15,533 tons, February 15,748 tons, March 18,031 tons.

A meeting of the South Staffordshire makers was recently held, when the question of another substantial cut in finished iron prices was discussed, but as the general impression prevailed that such action would fail to stimulate demand at present, no change in current quotations was announced at the quarterly meeting.

Tinplates.

Paradoxical as it may appear, the aspect of the tinplate market is certainly healthier than it has been for some time past, and the extent to which the supply of stock plates has been reduced within the last few weeks has enabled holders to become somewhat more independent. Very large clearances have been recently effected in the case of wasters, the accumulations of which were more particularly heavy, and the discount at which such material is obtainable has been appreciably reduced. Fair quantities of light wasters have been absorbed for shipment for India. Undoubtedly there is at present an undercurrent of feeling in the market that consumers' stocks are so low that they are bound to come into the market at no very distant date to cover their requirements, and it is, therefore, confidently anticipated that very shortly the prices of tinplates will more approximate the cost of production, which at the moment is about 4s. per basis box above merchants' views. The price of tinplates is round 28s. per ton, f.o.t., but works are holding out for at least 2s. per box more. Wasters are firm at 19s. 6d. for C.W., 14 by 20, 39s. 6d. to 40s. for C.W., 28 by 20, and 18s. to 18s. 6d. for C.W., 14 by 18¾, net, f.o.t. Terneplates continue in poor demand, and quotations are nominal at round 27s. 6d. per base box, net, f.o.t.

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Metals.

Copper.—The somewhat brighter aspect of the labour outlook has had a reassuring effect upon this week's metal markets, a more active demand for standard copper being reflected at Monday's opening, and with some good inquiries on consumers' account values had a stiffening tendency. Deliveries for May were marked at £69 10s. to £69 15s.; June, £69 10s. to £69 15s.; July, £70; while refined qualities were steady, electrolytic being quoted £71 to £74, and wire bars £73 to £74. The stocks of copper in Havre on April 15 are reported as 6,432 tons. Closing prices:—Cash: Wednesday, £69; Thursday, £68 12s. 6d.; Friday, £69; Monday, £69 15s.; Tuesday, £69 15s. Three Months: Wednesday, £69 2s. 6d.; Thursday, £68 15s.; Friday, £69 5s.; Monday, £70; Tuesday, £70.

Tin.—The market for this metal opened with a more confident tone, cable advices from the East reporting buyers at £167 10s. c.i.f., but no sellers, while improved prospects of an early settlement of current labour troubles imparted additional strength to values. Both cash and forward metal showed substantial appreciation, the latter attracting the attention of the chief operators, especially for May deliveries. Monday's turnover of 950 tons was the largest day's business recorded since July, while on balance, cash marked an advance of £8 5s. and three months £7, closing with a firm tone. April was done at £169 5s. to £169, closing at the first-named figure; May, £166 10s. to £170 5s; June, £171 to £171 10s.; July, £168 to £171 10s. English ingots closed £9 higher at £165 to £166. The weekly return of stocks in London showed a decrease of 202 tons at 3,954 tons; Liverpool, 45 tons less at 2,389; while at Swansea only 67 tons remain in stock. Closing prices:—Cash: Wednesday, £157; Thursday, £159; Friday, £160 15s.; Monday, £169; Tuesday, £168. Three Months: Wednesday, £161; Thursday, £162 10s.; Friday, £164 5s.; Monday, £171 5s.; Tuesday, £169 15s.

Spelter.—Business in the spelter market this week opened with a distinctly firm tone, sellers offers coming very sparingly, with the result that prices improved 7s. 6d. to 10s.; April selling £25 15s. to £25 17s. 6d.; May, £26 10s.; June, £26 15s. English was nominal at £29; electro 99.9, £33; prime Westerns, £26 10s.; remelted, £21 10s.; hard, £16 10s. to £17; zinc dust 92.94 per cent. nominal, £52 10s. to £65; zinc ashes 70 per cent. nominal, £6. Ordinary brands, prompt:—Closing prices: Wednesday, £25 10s.; Thursday, £25 2s. 6d.; Friday, £25 10s.; Monday, £25 15s.; Tuesday, £26.

Lead.—With only a quiet demand in evidence, the market for lead opened with a steady tone, and values for good soft pig near and forward appreciated 2s. 6d. The turnover amounted to about 300 tons, closing soft foreign prompt, £20 12s. 6d.; April, £20 15s.; May sold £21; and June at a similar figure. English pig was dearer at £22 5s.

To meet the demands of the future a development of the electricity undertaking at Worcester is anticipated, and the City Council, with that object in view, have under consideration a report of the Electricity Committee. It is estimated by the electrical engineer that a capital expenditure of about £62,200 will be necessary to carry out extensions.

Messrs. Samuel Saunders & Company, the well-known boat-building and aviation firm at East Cowes, who recently closed their works in consequence of labour troubles, have decided to re-open, employing only non-Union men. The directors arrived at this decision after consultation with the foremen, who agree to stand by the firm and resign from their Trade Unions.

The annual dinner of the Institution of Mining and Metallurgy was held at the Edward VII. Rooms, Hotel Victoria, London, on Wednesday, Mr. Frank Merricks, C.B.E., the president in the chair. Amongst those present were Colonel W. C. Blackett, C.B.E., Sir Peter Rylands, Sir Cecil Budd, K.B.E., Sir John Cadman, K.C.M.G., Dr. J. S. Haldane, F.R.S., Mr. Robert McLaren, M.P., Professor J. S. S. Brame (President of the Institution of Petroleum Technologists), Captain H. Riall Sankey, C.B. (President of the Institution of Mechanical Engineers), Sir Richard A. S. Redmayne, K.C.B., Sir Robert Hadfield, Bart., F.R.S., Sir Francis G. Ogilvie, C.B., Sir R. A. Blankenburg (Acting High Commissioner for the Union of South Africa), the Hon. Sir James Allen, K.C.B. (High Commissioner for New Zealand), and Lord Askwith, K.C.B. The toast of "The Institution of Mining and Metallurgy" was proposed by Sir James Allen, and the toast of "The Mining and Metallurgical Industries" was proposed by Sir Peter Rylands, and acknowledged by Sir Cecil Budd. Mr. W. H. Trewartha-James proposed the toast of "Our Guests," which was acknowledged by Colonel W. C. Blackett, president of the Institution of Mining Engineers, and Lord Askwith.

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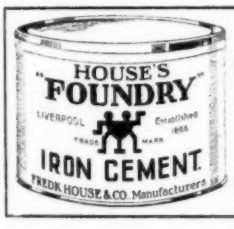

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¼ cwt. 1 cwt. CASKS
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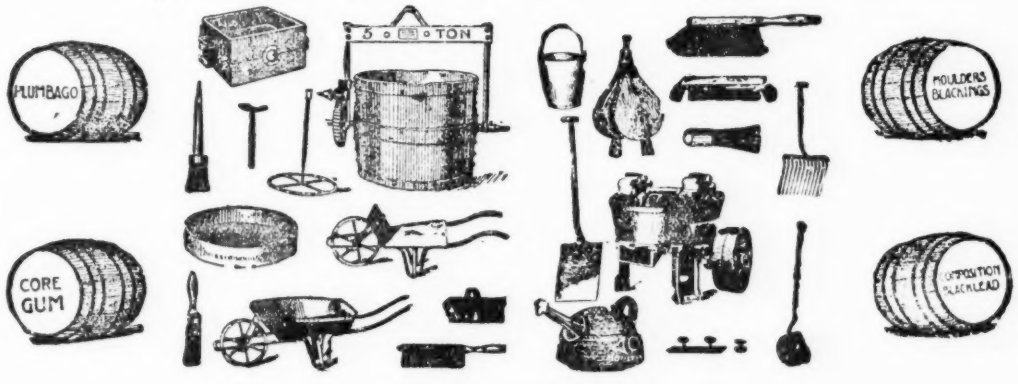

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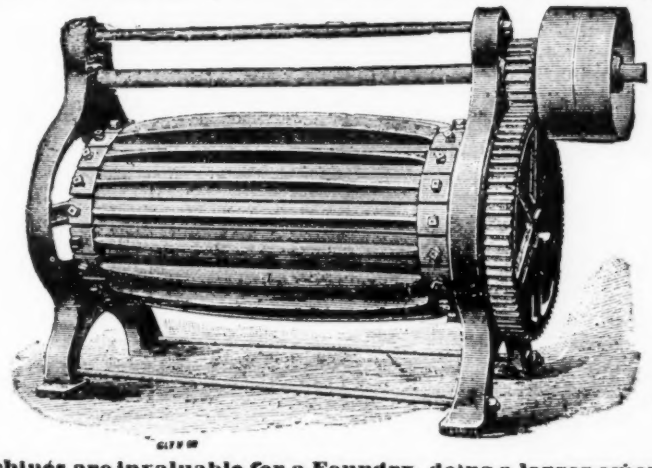
Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



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Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	69/15—69/17/6
Three months	70/0/0—70/2/6
Electrolytic	71 0 0
Tough	70 0 0
Best selected	70 10 0
Sheets	116 0 0
India	116 0 0
Wire bars	73 10 0
Do. May	73 10 0
Do. June	72 10 0
Ingot bars	72 5 0
H.C. wire rods	80 0 0
Off. aver. cash, Mar.	67 13 3⅞
Do. 3 mths., Mar.	67 7 0⅞
Do. Settlement Mar.	67 12 8⅝
Do. Electro, Mar.	71 15 0
Do. B.S., Mar.	69 18 10⅝
Aver. spot, copper, Mar.	67 12 7½
Do. Electro, Mar.	72 6 2½
Solid drawn tubes	15½d.
Brazed tubes	15½d.
Wire	12d.
Yellow metal rods	8½d.
Do. 4x4 Squares	10½d.
Do. 4x3 Sheets	10½d.

BRASS.

Solid drawn tubes	13½d.
Brazed tubes	16½d
Rods	12½d.
Sheets to 10 w.g.	11½d.
Wire	11½d.
Rolled metal	11½d.

TIN.

Standard cash	168/0—168/5
Three Months	169/15—170/0
English	165 0 0
Bars	167 0 0
Chinese	162 0 0
Straits	177 0 0
Australian	177 0 0
Eastern	166 0 0
Banca	184 0 0
Off. aver., cash, Mar.	156 4 7
Do. 3 mths., Mar	159 13 1½
Do. Stltment., Mar.	156 2 1½
Aver. spot, Mar.	156 0 3

SPELTER.

Ordinary	26 0 0
Remelted	21 10 0
Hard	16 10 0
Electro 99.9	33 0 0
English	29 0 0
India	19 10 0
Prime Western	26 10 0
Zinc dust	52 10 0
Zinc ashes	6 0 0
Off. aver., Mar.	25 10 5
Aver., spot, Mar.	25 1 6½

LEAD.

Soft foreign ppt	20 12 6
English	22 5 0
Off. average, Mar.	19 2 9½
Average spot, Mar.	18 18 2½

ZINC SHEETS.

Zinc sheets, spot	36 0 0
Do. V.M. ex. whf	36 0 0
Do. ppt., f.o.b., N.Y.	—
Dutch	35 0 0
Boiler plates	32 10 0
Battery plates	32 0 0

ANTIMONY.

English regulus	37 0 0
Special brands	42 0 0
Chinese	23 5 0
Crude	19 0 0

QUICKSILVER.

Quicksilver	12 10 0

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45/50%	17 10 0
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35/40%	25/- lb. va.
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70/80%	10/- lb. mo.
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23/25%, carbonless	1/6 lb.
Ferro-phosphorus, 20/23%	£32
Ferro-tungsten—	
80/85%, carbon free	1/10 lb.
Tungsten metal powder—	
98/99%	2/3 lb.
Ferro-chrome—	
4/6% car.	£37 10
6/8% car.	£37
8/10% car.	£36 0
Ferro-chrome—	
Max. 2% car.	£84
Max. 1% car.	£100
Max. 0.75% car.	£115
65/75%, carbonless	2/9 lb.
Nickel—99·8%, cubes or pellets	£195
Cobalt metal—97%.	19/0 lb.
Aluminium—98/99%	£150
Metallic Chromium—	
98/99%	6/6 lb.
Ferro-manganese—	
76/80%, loose	£20
76/80%, packed	£21
76/80%, export	£20
Metallic manganese—	
98/99%, carbonless	3/1 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 3 0
Finished bars, 18% tungsten	3 9
Scrap pieces	5d.
Turnings and swarf	3d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.

Rounds and squares under ½ in. to ¼ in. 3d. lb.

Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.

Bevels of approved sizes and sections 6d. lb.

If in coils 3d. lb.

Packing 4s. cwt

Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces	5d.
Turnings and swarf	3d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—£ s. d.	£ s. d.
Heavy Steel	3 5 0
Bundled steel & shearings	3 10 0
Mixed iron & steel 1 10 0	3 15 0
Heavy cast iron	4 15 0
Good machinery for foundries	6 5 0
Cleveland—	
Heavy steel	3 5 0
Steel turnings	3 0 0
Cast-iron borings	3 0 0
Heavy wrought iron piling	5 15 0
Bundling scrap	5 5 0
Cast-iron scrap	6 5 0
Lancashire—	
Cast iron scrap	7 0 0
Heavy wrought	4 0 0
Steel turnings	1 10 0
London—	
Copper (clean)	49 0 0
Brass (clean)	28 0 0
Lead (less usual draft)	16 10 0
Tea lead	14 10 0
Zinc	13 0 0
New aluminium cuttings	75 0 0
Braziery copper	39 0 0
Gun metal	45 0 0
Hollow pewter	110 0 0
Shaped black pewter	65 0 0

PIG-IRON.

N.-E. Coast—	
Foundry No. 1	125/-
Foundry No. 3	120/-
Forge No. 4	117/6
Mottled	117/6
Hematite No. 1	182/6
Hematite M/Nos.	180/-
Midlands—	
Staffs. common	145/-
,, part-mine forge	160/-
,, ,, foundry	170/-
,, Cold blast	340/-
,, basic	140/-
Northants forge	140/-
,, foundry No. 3	147/6
,, basic	140/-
Derbyshire forge	150/-
,, foundry No. 3	160/-
,, basic	150/-
Scotland—	
Foundry No. 1	170/-
,, No. 3	165/-
Hematite M/Nos.	180/-
Sheffield (d/d district)—	
Derby forge	155/-
,, foundry No. 3	160/-
,, basic	155/-
Lincs. forge	160/-
,, foundry No. 3	170/-
,, basic	162/6
E.C. hematite	193/-
W.C. hematite	196/-
All d/d in the district.	
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, foundry No. 3	170/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	172/6
,, foundry No. 3	177/6
Summerlee foundry	193/-
Glengarnock foundry	193/-
Gartsherrie foundry	193/-
Monkland foundry	193/-

FINISHED IRON & STEEL.

Iron—	£ s. d.
Bars (cro'n)	19 0 0
Angles	19 10 0
Tees to 3 united ins.	20 0 0
Nut and bolt	20 0 0
Hoops	23 0 0
Marked bars (Staffs.)	27 10 0
Gas strip	26 0 0
Bolts and nuts, ⅜ in. × 4 in.	40 0 0
Steel—	
Ship plates	19 0 0
Boiler plates	25 0 0
Checquer plates	20 0 0
Angles	17 10 0
Tees	18 10 0
Channels	18 0 0
Joists	17 10 0
Rounds, ½ in.–3-in.	16 0 0
Rounds, 3 in.–5½ in.	15 0 0
Flats, 5 in.–8 in.	15 10 0
Flats over 8 in.	15 0 0
Rails, heavy	15 0 0
Fishplates	20 0 0
Hoops	17 10 0
Black sheets, 24 g.	21 10 0
Galv. cor. sheets, 24 g.	23 10 0
Galv. fencing wire, 8 g. plain	25 0 0
Rivets, ⅝ in. dia	27 0 0
Billets, soft	13 0 0
Billets, hard	14 0 0
Sheet and tin bars	13 0 0

PHOSPHOR BRONZE.

Rolled.	Per lb. s. d.
½ in. to 1 in. wide	1 10¾
1 in. to 1½ in. wide	1 10½
1½ in. to 2 in. wide	1 8½

Strips.	s. d.
2 in. to 6 in. to 26 S.W.G.	1 8½
6 in. to 12 in. to 26 S.W.G.	1 8½

Sheets.	s. d.
12 in. to 18 in. to 24 S.W.G.	1 8½
18 in. to 24 in. to 24 S.W.G.	1 9¼
24 in. to 30 in. to 20 S.W.G.	1 10¼
30 in. to 36 in. to 16 S.W.G.	1 10¾
36 in. to 42 in. to 16 S.W.G.	1 11¾

Extras.

For Gauge: Any width up to 36 in. wide, ¼d. per lb. per thinner gauge.

Drawn Rods.	s. d.
¼ in. to ⅝ in. dia. in random lengths; ⅝ in. to 1¼ in. dia. in random lengths	1 9
Over 1¼ in. to 1¾ in.	1 9
Tubes—basis price	1 10¾

Delivery 2 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/1 to 1/7
Rolled—	
To 9 in. wide	1/8½ to 2/2½
To 12 in. wide	1/9 to 2/3
To 15 in. wide	1/10 to 2/4
To 18 in. wide	1/11 to 2/5
To 21 in. wide	2/- to 2/6
To 24 in. wide	2/1 to 2/7
Ingots for spoons and forks	1/1 to 1/7
Ingots rolled to spoon size	1/4 to 1/10
Wire round—	
3/0 to 10. G.	1/11 to 2/6

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	26.26
No. 2 foundry Valley	25.00
No. 2 foundry, Birm.	25.00
Basic	24.96
Bessemer	26.96
Malleable	26.96
Grey forge	25.96
Ferro-manganese 80 % delievred	90.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	38.00
O.-h. billets	38.00
O.-h. sheet bars	38.00
Wire rods	52.00
	Cents.
Iron bars, Phila.	2.35
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.10
Skelp, sheared steel	2.45
Steel hoops	2.75
Sheets, black, No. 28	3.75
Sheets, galv., No. 28	4.75
Sheets, blue an'l'd, 9&10	3.00
Wire nails	3.00
Plain wire	3.00
Barbed wire, galv.	3.85
Tinplate, 100-lb. box	$7.00

COKE.

Welsh foundry	67/6
,, furnace	55/-
Durham & North. foundry	70/-
,, furnace	42/6
Other Districts, foundry	77/9
,, furnace	45/-

SWEDISH IRON.

Bars, hammered basis sizes	Basis price	£35 to £37
Rolled Ordinary— Assortment ..	£26 0 0	to
Nail Rods— Square, round and flats ..	£27 0 0	
Keg Steel / Faggot Steel	about £40	Prices nominal.
Blooms— Single welded ..		£17 to £19
Billets— Single and double welded ..		£20 to £25
Pig-Iron— Grey, white or mottled ..		£14 to £16

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas ..	−10%	−15%
Water ..	net	− 6¼%
Steam ..	+11¼%	+ 3¾%

TINPLATES.

I.C. Cokes,	20×14, box	28/-
,,	28×20, ,,	53/-
,,	20×10, ,,	37/-
,,	18¾×14, ,,	30/-
I.X.	,,	73/-
I.X.X.	,,	103-
F.C.B.Y.	21×13⅝ ,,	50/6
C.V.B.G.	16½×15, ,,	50/-
I.C.W.	20×14, ,,	19/6
,,	28×20, ,,	39/6
,,	20×10, ,,	28/6
,,	18¾×14, ,,	18/3
Terneplates,	28×20, ,,	55/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Apr.13	69 0 0	No change
,, 14	68 12 6	dec 7/6
,, 15	69 0 0	inc. 7/6
,, 18	69 15 0	inc. 15/-
,, 19	69 15 0	No change

Electrolytic Copper (Cash).

Apr.13	72 10 0	No change
,, 14	72 0 0	dec. 10/-
,, 15	71 0 0	,, 20/-
,, 18	71 0 0	No change
,, 19	71 0 0	No change

Standard Tin (cash).

Apr.13	157 0 0	dec. 90/-
,, 14	159 0 0	inc. 40/-
,, 15	160 15 0	,, 35/-
,, 18	169 0 0	,, 165/-
,, 19	168 0 0	dec. 20/-

Tin (English Ingots)

Apr.13	154 0 0	dec. 100/-
Apr.14	154 0 0	No change
,, 15	160 15 0	inc. 135/-
,, 18	165 0 0	,, 85/-
,, 19	164 0 0	dec. 20/-

Zinc Sheets (spot).

Apr.13	36 0 0	No change
,, 14	36 0 0	No change
,, 15	36 0 0	No change
,, 18	36 0 0	No change
,, 19	36 0 0	No change

Spelter (ordinary).

Apr.13	25 10 0	dec. 10/-
,, 14	25 2 6	,, 7/6
,, 15	25 10 0	inc. 7/6
,, 18	25 15 0	,, 5/-
,, 19	26 0 0	,, 5/-

Lead (English).

Apr.13	22 5 0	No change
,, 14	22 0 0	dec. 5/-
,, 15	22 0 0	No change
,, 18	22 5 0	inc. 5/-
,, 19	22 5 0	No change

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BARS, ANGLES, TEES and PLATES.

HOOPS delivered F.O.B. Liverpool.

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93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

THE BRITISH CAST-IRON RESEARCH ASSOCIATION.

DIRECTOR OF RESEARCH.

The Council invite applications for the post of Director of Research to the above Association. Applicants must state age and give full particulars of training, experience in General Metallurgy, especially in Cast-iron Foundry Practice, Laboratory and Research Work, and state salary required.

Applications, endorsed "Director," should be addressed "The Chairman, British Cast-Iron Research Association," and to be received by May 9, 1921.

Canvassing is prohibited.

THOS. VICKERS,
Secretary.

Central House, New Street, Birmingham.
April 16, 1921.

GENTLEMAN, with practical engineering experience as Works Manager, and possessing thorough knowledge of the commercial side of engineering, requires position. Highest references.—Box 555, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PARTNERSHIP

A PARTNER is required for an Engineering and Foundry Business in a large industrial centre, or would sell. Capital required about £2,000.—Apply Box 732, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

TENDERS

TENDERS.—The Commissioners of His Majesty's Works, etc., are prepared to receive Tenders, before 11 a.m. on Monday, 25th April, 1921, addressed to the Secretary, H.M. Office of Works, etc., Storey's Gate, Westminster, London, S.W.1, for the supply of STEEL LOCKERS. Forms of Tender, etc., may be obtained on application to the Controller of Supplies, H.M. Office of Works, etc., King Charles Street, Westminster, London, S.W.1.

MACHINERY.

FOR SALE.—Lathe, in excellent condition, 9 in. centre, 16 ft. overall, complete with shafting and pulleys. Suction Gas Engine, 50 h.p. Stockport, cylinder 15 in. dia., 22 in. stroke, in good working order when dismantled.—For further particulars, apply D. D. Evans & Co., Metal Merchants, Pontardulais, Glam

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NEW 3-TON HAND DERRICK CRANE, with 45 ft. timber jib, two wired ropes.

SECOND-HAND HAND DERRICK CRANES, 3, 2½, 2, 1½ and ½-ton capacity.

5-Ton HAND FOUNDRY CRANE, 24 ft. radius, constructed mostly of built-up channels.

10-TON TOWER-TYPE STEAM NAVVY (Ruston Proctor), with bucket 1½ cubic yards capacity; gauges 4 ft. 8½ in. and 11 ft.; boiler 8 ft. 6 in. by 3 ft. 6 in., for 100 lbs. W.P.

"PRICE'S" SINGLE-CHAIN GRAB, about 1¼ cubic yards capacity.

5-TON STEAM DERRICK CRANE, with 40 ft. split timber jib, all complete.

6 ft. MORTAR MILL, WITH VERTICAL ENGINE AND BOILER COMBINED, the lot mounted on steel carriage, with flat-faced road-travelling wheels.

5 ft. 6 in. OVER-DRIVEN MORTAR MILL, fixed rollers, revolving pan, and fast and loose pulleys.

10 ft. OVER-DRIVEN PERFORATED CLAY GRINDING MILL, with gathering-up pan underneath, and four sets of perforated grids.

CATALOGUE OF STOCK MACHINERY. 5-6,000 LOTS, FREE ON APPLICATION. INSPECTION INVITED.

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MISCELLANEOUS.

ORDERS WANTED for small Machine-made Castings in Brass, Gunmetal, Phosphor, or Manganese Bronze. Also Castings any size up to one ton in weight. Prompt delivery.—James G. Crowther, Paradise Street Brass Foundry, Sheffield.

CASTINGS (IRON) ORDERS WANTED for any weight and size (Yorkshire District). Machines if necessary.—Address, Box 728, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WE Specialise in Aluminium Castings, die and sand. Enquiries solicited. Prompt deliveries. Also Castings in Brass, Gunmetal and Phosphor or Manganese Bronze.—H Perks & Co., 90, Seymour Place, W.1.

ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to 5 cwt. Complete Machines built throughout to specification, singly or in quantity. Jig and Tool Work a speciality.—C. S. Peatfield, Limited, Market Rasen, Lincs.

PATTERNS and CASTINGS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited. Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with Videx Pattern Works and Foundry, Huntsworth Mews, Upper Baker Street, London, N.W.1. (Telephone, Paddington 364).

FOR SALE, cheap, Foundry Pig Iron, all sections, F.B. Steel Rails, with all accessories; Joists, Channels, Angles, Sheets and Plates, all thicknesses; plumbago.—Ascoc, Golder's Green, London. Telephone; Hampstead, 1806.

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GOVERNMENT Surplus, 3,300 Bastard Files, 8 to 14 in., 132 dozen half-round 6 in., 120 round 10 in., 3 tons 18 and 34 G Bright Wire in coils, 5,000 ft. new Balata Belting, 100 reams Oakey's Emery Cloth and other goods; bargain.—Write for particulars, John Taylor & Sons (1920), Limited, Norland Road, Notting Hill, London.

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The NORTHGATE IRONWORKS Co.
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Finest Modern Foundry in the Eastern Counties.
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